The Blast Furnace and Steel Plant

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Index to Contents

VOL. VI. OCTOBER, 1918. NO. 10

Page

CEMENT GUN USED IN REPAIRING PIT STACKS 399

A. I. S. E. E. TWELFTH ANNUAL CONVENTION 402

CHARACTERISTICS OF AUTOMATIC ENGINE STOPS 405
BY WALTER GREENWOOD.

REMOTE CONTROLLED SUB-STATION DESCRIBED 408
BY W. T. SNYDER.

STANDARDIZING LARGE ROLLING MILL MOTORS 411
BY K. A. PAULY.

PROBLEMS OF STEAM CYLINDER LUBRICATION 414
BY W. F. OSBORNE.

ELECTRICALLY-DRIVEN MILLS AT BETHLEHEM 417
BY W. T. STURTEVANT.

FUEL ECONOMY IN BLAST FURNACE PRACTICE 419
BY T. C. HUTCHINSON.

Page

OPERATING RULES FOR ELECTRIC CRANES 421

OVERHEAD TRAVELING CRANE BRIDGE MOTORS 423
BY R. H. MCLAIN.

EDUCATING STEEL MILL ELECTRICAL EMPLOYES 427

TURBINE GIVES ADDITIONAL LINE SHAFT POWER 430

COMMENT ON PRESENT ELECTRODE SITUATION 433

PRODUCTION TOPICS 434

NEWS OF THE PLANTS 435

SOME POINTERS ON BY-PRODUCT COKE OVEN OPERATION 436

INDUSTRIAL SAFETY 437

OPEN HEARTH 438

WITH THE EQUIPMENT MANUFACTURERS 440

TRADE NOTES, TRADE PUBLICATIONS, OBITUARY, SOCIETY MEETINGS 442

UNIVERSITY OF MICHIGAN

The Blast Furnace and Steel Plant

Cement Gun Used for Repairing Pit Stacks

Gases Corrode Stack of Pit Furnace, Necessitating New Shell. Steel Reinforcement Is Placed on Old Shell and Gunite Applied, Making Practically a New Stack With Little Delay.

An extremely interesting piece of repair work has just been finished by the Baker-Dunbar-Allen Company of Pittsburgh on some pit stacks at the Pittsburgh Crucible Steel Company of Midland. At the latter plant five self-supporting stacks, which are 125 feet high and approximately 6 feet in diameter at the top, were very badly corroded due to the gas from the furnaces finding its way through the brick lining of the stacks and eating out the steel plate. The corrosion became very general. In places a man could thrust his forearm through the plate and it became absolutely necessary to rebuild or repair the stacks.

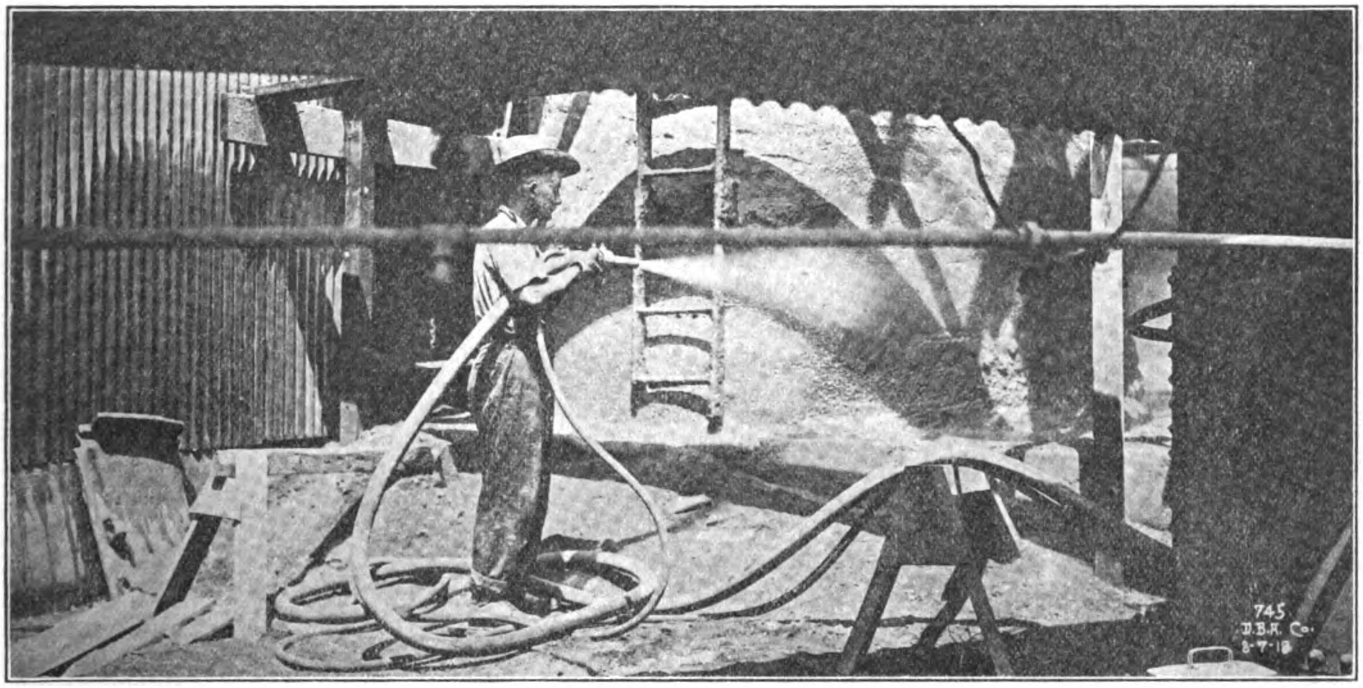


Fig. 1—Method of applying gunite to base of steel stack at Pittsburgh Crucbile Steel Co

The Baker-Dunbar-Allen Company advanced the novel idea of building reinforced, self-supporting shells around these stacks by employing the cement gun. Accordingly, all details were carefully worked out. The stacks are now completed and the construction work proven entirely satisfactory.

At each ring hook bolts were tapped into the stack, these hook bolts carrying steel bands properly spaced from the stack, the bands in turn carrying vertical reinforcing rods of square twisted steel, around which is wrapped wire mesh. The Gunite shell has been applied against this reinforcement.

Fig. 2 shows clearly the details of construction. Fig. 5 shows the cement gun in position and the air-compressing plant. Fig. 3 shows stack No. 1 completed, with the scaffolding in process of dismantling, and stack No. 2 with the steel work completed and the Gunite at the base applied. Fig. 1 shows the nozzle man applying the material. Fig. 4 is a close-up view of stack No. 2, showing steel reinforcement and applied material. Note the nicety of the application of the steel reinforcement in this photograph.

The great advantage in this method of building these stacks lies in the fact that the stacks have been kept in constant operation during the progress of the work, except for a few days on each stack while the Gunite was being applied to the upper portions of the stack. During these few days each stack was cut out of service so that the material would not dry out too quickly, the upper portions of the stack receiving less protection from the heat of the gases than the lower portions.

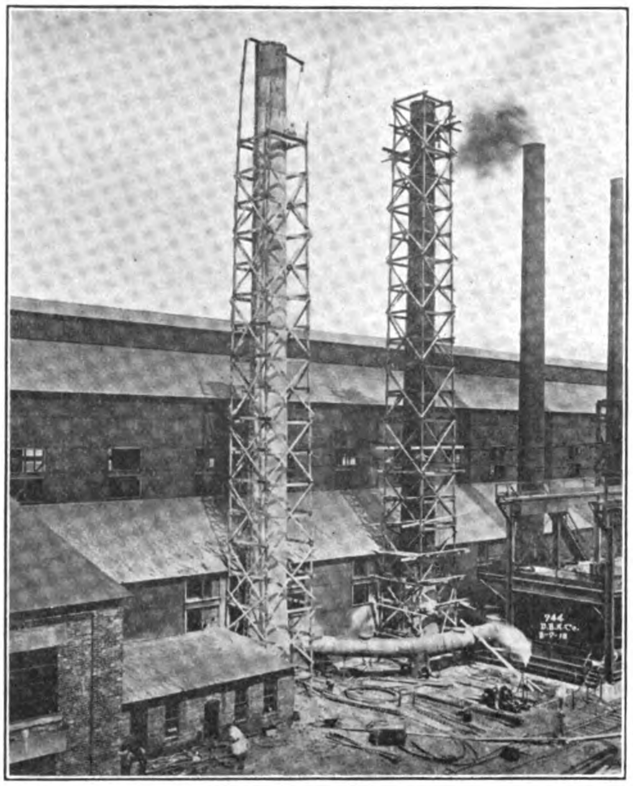


Fig. 3—Stack completed scaffolding being removed. The stack is now absolutely independent of the old, new steel shell being self-supporting.

The method of construction employed also resulted in less expense than the building of forms around the present steel stacks and the application of ordinary concrete. The speed of the work also is much superior, inasmuch as the operating force is applying 20 to 25 feet of Gunite in a day, instead of the ordinary 5 or 10 feet possible with the use of forms and ordinary concrete.

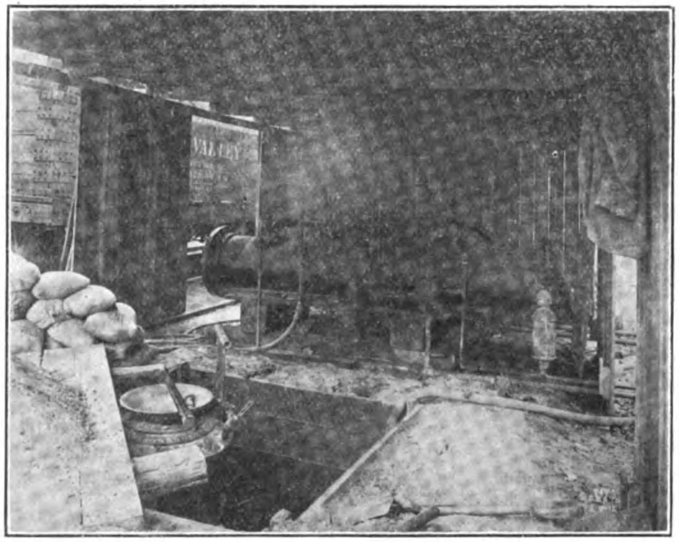


Fig. 5—Cement gun in position and air compressor plant.

Each stack requires 1,100 cubic feet of finished Gunite, which is reinforced with about 1½ per cent of steel. After the completion of stack No. 2 it was thought that better results would be obtained by the use of swinging scaffolds of special design instead of the continuous timber scaffolds as shown on photographs. The swinging scaffolds have been used, with improved success over the timber scaffolds.

Several niceties of design and construction methods have been worked out in connection with the work and credit is due for the successful outcome to the engineering staff of the Pittsburgh Crucible Steel Company, notably H. A. Kunitz, assistant mechanical engineer, and also to their president, Mr. Dougherty, for his careful consideration of the matter and final determination to proceed with the unusual method employed. Credit is also due the engineering staff of the Baker-Dunbar-Allen Company and their construction staff, the actual work being in charge of J. P. Clarke, superintendent of construction, under the supervision of W. F. Glasser, general superintendent.

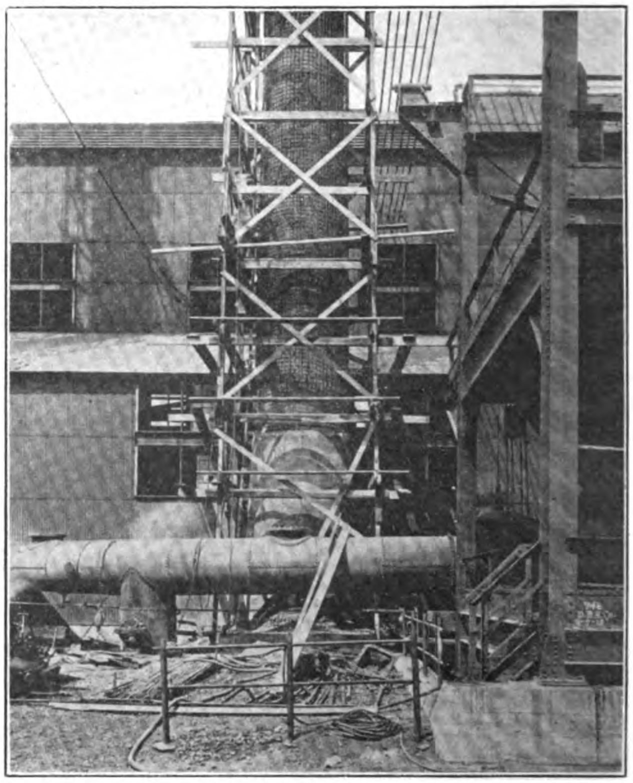
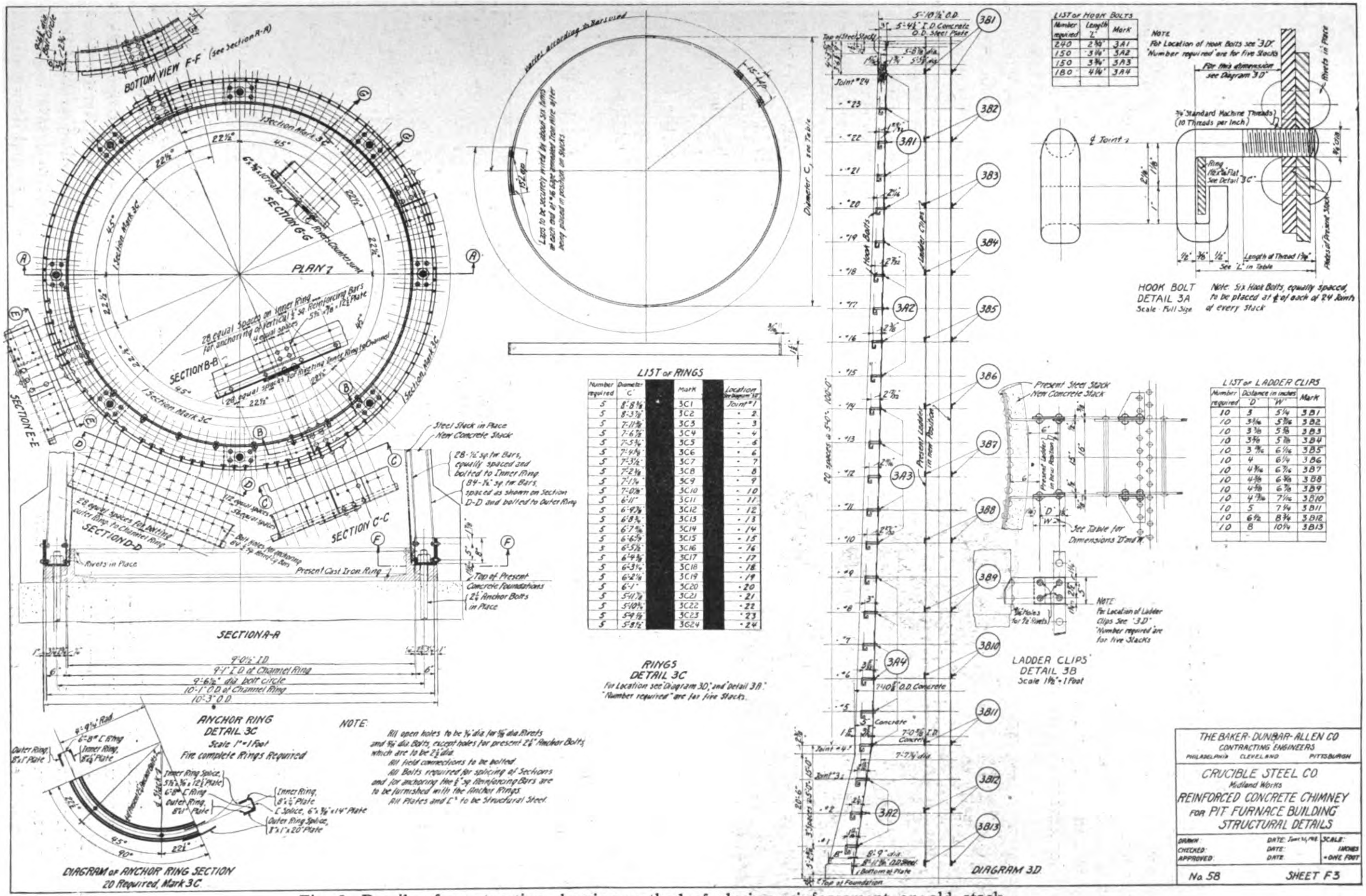


Fig. 4—View showing steel reinforcement.

Undoubtedly, this gunite method could be applied to a great many stacks which are in a poor state of repair, and should be of particular interest to steel mill operators. The Baker-Dunbar-Allen Company will furnish information for similar construction.


BOTTOM VIEW F-F (see Section A-A)
PLAN 7
SECTION G-G
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION A-A
Section Mark 3C
28 equal Spaces on Inner Ring for anchoring of Vertical ½" sq. Reinforcing Bars
Steel Stack in Place
New Concrete Stack
28-½" sq. tw Bars, equally spaced and bolted to Inner Ring
84-½" sq. tw Bars, spaced as shown on Section D-D and bolted to Outer Ring
Present Cast Iron Ring
Top of Present Concrete Foundations
2¼" Anchor Bolts in Place
Rivets in Place
9'-0½" I.D.
9'-1" I.D. of Channel Ring
9'-6½" dia. bolt circle
10'-1" O.D. of Channel Ring
10'-3" O.D.
ANCHOR RING
DETAIL 3C
Scale 1" = 1 Foot
Five complete Rings Required
Outer Ring, 8'x½" Plate
Inner Ring, 8'x½" Plate
Inner Ring Splice, 5½"x⅝"x12½" Plate
6"-8" C Ring
Outer Ring Splice, 5"x½"x20" Plate
C Splice, 6"x⅜"x14" Plate
DIAGRAM OF ANCHOR RING SECTION
20 Required, Mark 3C
Diameter C, see Table
Laps to be securely wired by about six turns at each end of ⅛" dia. annealed Iron Wire after being placed in position on Stacks.
Varies according to Bars used
RINGS
DETAIL 3C
For Location see "Diagram 3D," and "Detail 3A."
"Number required" are for five Stacks.
Top of Steel Stack
5'-10⅝" O.D.
5'-4½" I.D. Concrete
O.D. Steel Plate
Joint #24
Hook Bolts
Ladder Clips
Present Ladder (in new Position)
20 spaces @ 5'-0" = 100'-0"
7'-4⅝" O.D. Concrete
Concrete
Bottom of Plate
Top of Foundation
DIAGRAM 3D
3A1
3A2
3A3
3A4
3B1
3B2
3B3
3B4
3B5
3B6
3B7
3B8
3B9
3B10
3B11
3B12
3B13
Present Steel Stack
New Concrete Stack
See Table for Dimensions "D" and "W"
LADDER CLIPS
DETAIL 3B
Scale 1½" = 1 Foot
HOOK BOLT
DETAIL 3A
Scale Full Size
¾" Standard Machine Threads (10 Threads per Inch)
For this dimension see Diagram "3D"
Ring Flat See Detail "3C"
Length of Thread 1⅜"
See "L" in Table
Plates of Present Stack
¢ Joint

NOTE
All open holes to be ¾" dia. for ⅝" dia. Rivets and ⅝" dia. Bolts, except holes for present 2¼" Anchor Bolts, which are to be 2½" dia.
All field connections to be bolted.
All Bolts required for splicing of Sections and for anchoring the ½" sq. Reinforcing Bars are to be furnished with the Anchor Rings.
All Plates and C's to be Structural Steel.

LIST OF RINGS

Number required	Diameter "C"	Mark	Location (see Diagram "3D")
5	8'-8⅛"	3C1	Joint #1
5	8'-3⅞"	3C2	" 2
5	7'-11⅝"	3C3	" 3
5	7'-6⅞"	3C4	" 4
5	7'-5¾"	3C5	" 5
5	7'-4⅝"	3C6	" 6
5	7'-3½"	3C7	" 7
5	7'-2⅜"	3C8	" 8
5	7'-1¼"	3C9	" 9
5	7'-0⅛"	3C10	" 10
5	6'-11"	3C11	" 11
5	6'-9⅞"	3C12	" 12
5	6'-8¾"	3C13	" 13
5	6'-7¾"	3C14	" 14
5	6'-6⅝"	3C15	" 15
5	6'-5½"	3C16	" 16
5	6'-4⅜"	3C17	" 17
5	6'-3¼"	3C18	" 18
5	6'-2⅛"	3C19	" 19
5	6'-1"	3C20	" 20
5	5'-11⅞"	3C21	" 21
5	5'-10¾"	3C22	" 22
5	5'-9⅝"	3C23	" 23
5	5'-8½"	3C24	" 24

LIST OF HOOK BOLTS

Number required	Length "L"	Mark
240	2¾"	3A1
150	3¼"	3A2
150	3¾"	3A3
180	4¼"	3A4

NOTE
For Location of Hook Bolts see "3D."
"Number required" are for five Stacks
Note: Six Hook Bolts, equally spaced, to be placed at ¢ of each of 24 Joints of every Stack

LIST OF LADDER CLIPS

Number required	Distance in inches "D"	Distance in inches "W"	Mark
10	3	5¼	3B1
10	3 1/16	5 5/16	3B2
10	3⅛	5⅜	3B3
10	3⅝	5⅞	3B4
10	3 13/16	6 1/16	3B5
10	4	6¼	3B6
10	4 3/16	6 7/16	3B7
10	4⅜	6⅝	3B8
10	4⅝	6⅞	3B9
10	4 13/16	7 1/16	3B10
10	5	7¼	3B11
10	6½	8¾	3B12
10	8	10¼	3B13

NOTE
For Location of Ladder Clips see "3D"
"Number required" are for five Stacks

THE BAKER-DUNBAR-ALLEN CO
CONTRACTING ENGINEERS
PHILADELPHIA CLEVELAND PITTSBURGH

CRUCIBLE STEEL CO
Midland Works
REINFORCED CONCRETE CHIMNEY
FOR PIT FURNACE BUILDING
STRUCTURAL DETAILS

DRAWN: DATE: June 14, 1918 SCALE:
CHECKED: DATE: INCHES
APPROVED: DATE: = ONE FOOT

No. 58 SHEET F3

Fig. 2—Details of construction showing method of placing reinforcement on old stack.

A. I. S. E. E. 12th Annual Convention

Electrical Engineers Discuss Standardization and Safety, at Baltimore, and Present Interesting Papers—Inspect Steel Works and Shipyards of Bethlehem Steel Co.—D. M. Petty Elected President.

Although not attended by as many members as some previous conventions, the twelfth annual convention of the A. I. S. E. E. was very successful. The meeting was opened by President Menk on Wednesday morning, September 11. At this business session officers were elected and committee reports presented, the following efficers being elected: President, D. M. Petty, superintendent, electrical department, Lehigh works, Bethlehem Steel Company, Bethlehem, Pa.; first vice president, B. W. Gilson, superintendent, electrical department, Ohio works, Carnegie Steel Company, Youngstown, O.; second vice president, H. C. Cronk, superintendent, electrical department, McKinney Steel Company, Cleveland, O.; treasurer, James Farrington, superintendent, electrical department, La Belle Iron Works, Steubenville, O.; secretary, John F. Kelly; directors, E. S. Jeffries, electrical engineer, Steel Company of Canada, Hamilton, Ont.; G. W. Richardson, superintendent, electrical department, Pencoyd works, American Bridge Company, Pencoyd, Pa.; F. A. Wiley, superintendent electrical department, Wisconsin Steel Company. South Chicago, Ill.; Walter Kennedy, superintendent, electrical department, Pittsburgh Crucible Steel Company, Midland, Pa.

D. M. Petty.
Superintendent electrical department, Bethlehem Steel Company, South Bethlehem, Pa. Newly-elected president of A. I. S. E. E.

A. H. Swartz.
Westinghouse Electric & Manufacturing Co., chairman of convention committee.

"Rules for Safe Operation of Electric Cranes" was the first paper presented. The paper, which appears in full in this issue of the Blast Furnace and Steel Plant, was prepared by the safety committee of the association, and dealt with suggested rules applicable to cranes actuated entirely by electric current. W. S. Hall in discussing this paper urged simplicity with regard to rules and suggested that it is not necessary to lock switch when craneman leaves cab as recommended in the paper. E. R. Kagarise pointed out that confusion results when two or three men attempt to signal at one time and particularly urged the use of lock switches. William E. Waldron described a safety crane switchboard used at the Shenango works of the American Sheet & Tin Plate Co. which takes the place of the ordinary knife switches and fuses, and consists of two magnetic switches, or contactors, in the main circuit, overload relays in the motor circuits, a "start and stop" push button station and a safety plug. This device performs some of the duties of the crane operator.

Barney W. Gilson read the report of the educational committee, reading the paper entitled "Methods of Education for Electrical Employes of Iron and Steel Mills." The paper was thoroughly prepared, and it is to be hoped the A. I. S. E. E. will take some definite action to bring about the benefits which the adoption of the suggestions presented in this paper would mean to the electrical engineers in the steel industry.

In a discussion contributed by H. A. Andresen, president of the National Iron and Steel Publishing Company, the advisability of the community system of education was urged. Grant Armor pointed out that, responsibility when placed upon a student is one of the most efficient means to create interest and incentive for additional educational desire. B. A. Corn-

Walter Greenwood.
Safety engineer Carnegie Steel Co., Ohio Works, author of paper on "Automatic Engine Stops."

R. H. McLain.
Engineer power and mining department, General Electric Company, Schenectady, N. Y. Author of paper on "Bridge Motors for Overhead Traveling Crane."

wall said in part: "I personally would like to see the electrical superintendents present get together on this matter and agree to institute in their respective organizations an educational system such as outlined, and if the course should be adopted I would suggest that it be known as the A. I. S. E. E. course of instruction for electrical employes."

"Automatic Engine Stops" were then discussed by Walter Greenwood. The author dwelt in particular on the superiority of electrically operated stops over mechanically operated stops; the causes of failure of stops were thoroughly presented.

In discussing Mr. Greenwood's paper, E. J. Schwarznau pointed out that a mechanical system for automatic engine stops has not proven satisfactory and that in his experience he had found it necessary to eliminate mechanical systems entirely and change over to electrically operated systems, and stated that the low voltage system had been most successfully used. H. Jones favored a mechanical and electrical combination of safety stop, provided that the mechanical device is of a short coupled type and few parts, and added that frequent testing is of prime importance to avoid failure. James L. Mills added to the discussion, saying, "It would seem that the only way to know a stop is in good order, and to be relied on, is to try it; possibly not by bringing the engine up to a speed approaching danger, but rather by equipping the stop with some adjustment by which it will operate at a speed of 5 or 10 per cent below the speed deemed dangerous and then make use of this stop at least once in 24 hours to actually shut the engine down."

R. H. McLain presented a paper on "Overhead Traveling Cranes," opening the Thursday morning session. This paper contained a great deal of valuable and interesting discussion and evoked considerable discussion.

D. D. PENDLETON.
Wheeler Condenser & Engineering Co., author of paper "Condensers and Condenser Engineering Practice."

K. A. PAULY.
Electrical engineer power and mining department, General Electric Company, Schenectady, N. Y. Author of paper "Standardization of Rating of Large Rolling Mill Motors."

In discussing this paper, A. B. Holcomb did not fully agree that the bridge motor is most commonly the trouble, although adding that his experience had been with cranes not requiring high bridge acceleration. He further suggested dynamic stopping on both bridge and trolley motors. This method would exert the maximum braking possible when the controller is thrown to the off position without slipping the wheels. F. A. Wiley suggested that if the bridge of a crane is of sufficient weight to require two motors, that the most satisfactory method of drive would be to place one motor on each side of the bridge in the center of the span, applying the method to all four traction wheels. The motors being connected either in parallel or independently through two separate magnetic controllers, the two controllers to be operated by one master controller. This method gives two independent drives and eliminates the trouble of one motor "hogging" the load.

W. T. SNYDER.
Superintendent of electrical department National Tube Company, McKeesport, Pa., past president of A. I. S. E. E. and author of paper "Remote Controlled Sub-station."

J. E. FRIES.
Chief electrical engineer, Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.

One of the most valuable contributions to the permanent proceedings of the A. I. S. E. E. was the paper prepared by D. D. Pendleton, in which the author comprehensively covered the subject of modern manufacturing practice and ratings, types of condensers and auxiliaries, their power requirements and practical limitations.

Following Mr. Pendleton's paper, F. A. Burg emphasized the necessity of selecting a condenser with proper regard to the conditions under which it will be operated. He further said in part: "Under the subdivision of 'choice of condenser' it was brought out that the jet condenser would take 170 per cent more power than the surface condenser for a cooling tower position. I question this. In the first place, the total head of 81 feet given for the low level jet should be reduced to at least 75 feet and the efficiency realized on the jet condenser pump would be better than 50 per cent, say 60 per cent. This means that the total operating head would be reduced from the figures of 162 feet given to approximately 125 feet." Following this line of reasoning, Mr. Burg stated that according to his calculations not more than 50 per cent more power would be required by the jet condenser.

A paper prepared by K. A. Pauly opened the afternoon session with a discussion on "Standardization of Large Rolling Mill Motors," pointing out the difficulties of the users of large rolling mill motors due to the present difference in methods of rating. The discussion following the paper demonstrated that the body present was generally very favorably inclined toward standardization.

O. Schaumberg strongly endorsed the value and the necessity of standardization as presented by Mr. Pauly. J. D. Wright agreed with J. E. Fries in taking exception to the statement that "the root mean square varies directly as the tonnage," explaining that the tonnage might be increased by rolling the same ingot to a larger bloom or decreased by rolling the same ingot to a smaller bloom without changing the r.m.s.

J. T. Sturtevant's paper on "Electrically Driven Mills" described the layout, equipment, power, consumption and tonnage on 11 installations at the Lehigh plant of the Bethlehem Steel Company.

F. A. Crosby expressed himself as being in favor of motor rooms and forced ventilations in discussing Mr. Sturtevant' paper. H. H. Craiglow, while agreeing with the author regarding the advantage of the electrically driven mill in this particular case, pointed out that this represented the conditions of only one local installation. He also stated that due to the close proximity of boilers that there might be times when a steam drive would have advantages over an electrical drive. A. B. Holcomb, referring to the matter of oil changes, stated that in his experience at the Standard Tin Plate Company, Canonsburg, no changes of oil on the motor bearings were required.

Howard Maxwell explained that for two-speed motors it is possible to utilize one winding and change the grouping of the coils for the two speeds, but in general the number of stator terminal leads is so great and the control so complicated that it is impossible.

"Remote Controlled Substations" were discussed by W. T. Snyder on Friday morning, in which he described a remote controlled motor generator substation, located about 2,200 feet from the main power station and feeding into a 250 volt d. c. transmission line.

The report of the standardization committee was of great interest and was thoroughly discussed. Advocating single rating for large motors, F. B. Crosby, chairman of the committee, said in part: "A universal method of rating would greatly facilitate an intelligent comparison of competitive bids by insuring equality of normal output, temperature and commutation," the report stated. "It would also permit of direct comparison of existing installations.

"Present ratings among others are:

	(a)	(b)	(c)	(d)	(e)
Per cent load	100	100	100	100	100*
Hours	Cont.	Cont.	Cont.	Cont.	Cont.
Temp. raise	40°C.	35°C.	40°C.	40°C.	50°C.
Per cent load	125	125	125	125	...
Hours	2	Cont.	Cont.	Cont.	...
Temp. raise	55°C.	50°C.	50°C.	Without injury	
Per cent load	..	150	150	...	...
Hours	..	1	1	...	...
Temp. raise	...	60°C.	60°C.	...	...

*Maximum.

"It has been suggested that a single rating be adopted for all large motors, alternating or direct current, reversing or non-reversing, which will take into account horsepower output and corresponding temperature rise for a specified period.

"To meet this condition, motors should be designed for a rated capacity equal to their estimated load plus the desired marginal capacity.

"From the standpoint of design and operation, it would have been far better if instead of (b) calling for a motor capable of carrying 125 per cent load continuously with 50 degrees C. rise, a motor of 25 per cent larger, capable of carrying 100 per cent load continuously with 50 degrees C. temperature rise had been specified."

Alfred J. Stanton, of the Bethlehem Steel Company, suggested that the engineers should take steps to design standardized apparatus rather than leave the entire burden to the equipment manufacturers.

Gordon Fox explained that a rating based on maximum capacity is not definite unless qualified by a statement as to the proportionate time periods during which this maximum capacity is employed.

In addition to the technical session a patriotic meeting was held Thursday afternoon and the annual banquet in the evening of the same day. On Friday afternoon the members visited the Bethlehem Steel Company plant at Sparrows Point. Saturday morning the Hess Steel Company was visited.

The electric welding committee of the Emergency Fleet Corporation held a joint session with the Philadelphia sections of the A. I. & S. E. E. and A. I. E. E., and the Engineers' Club of Philadelphia, at the Bellevue-Stratford Hotel, Philadelphia, September 16, at 8 p. m. The subject "Electric Welding a New Industry" was discussed at this meeting.

This paper covered a brief review of the uses of electric spot and arc welding in this country prior to the formation of the electric welding committee of the Emergency Fleet Corporation. It compared the status of the art at the present time and emphasized the developments that have been made in apparatus during the last six months. It explained the activities of the welding committee in applying electric welding processes to the shipbuilding industry and pointed the way to the general applicability of this method to other industries. The results obtained by investigation and physical tests, as shown in this paper prove the applications of this process to heavy work are satisfactory.

Characteristics of Automatic Engine Stops

Why Speed Regulators Fail and Why Substitutes Should Be Provided for Emergencies—Cause and Prevention of Failure. Mechanically and Electrically Operated Stops Are Compared.

By WALTER GREENWOOD.

Automatic stops with the same general principles involved in their construction can be applied to various purposes, but in this discussion they will be termed engine stops, to avoid confusion. There should be no confusion in regard to the classes of work performed by automatic engine stops and speed regulators, yet many installations are made where speed regulators along with engineers in charge are depended upon to prevent overspeeding.

All kinds of apparatus for regulating engine speed are known as governors or speed controllers. There are various designs, most of which are dependent on centrifugal force for bringing them into action, and this seems to be the most convenient and reliable force that can be applied. While the force itself is positive and measurable, the resistances that effect the reliability of controllers are various. With all conditions remaining constant the action of a controller must be positive. The causes for variations of resistance are numerous and among them may be mentioned gumming of parts with non-volatile matter contained in grease or that is carried with steam from boilers; oxidation of metallic parts, and pressure of packing. In addition, wearing of parts affect adjustment; breakage of a part may entirely destroy the usefulness of a controller and permit a wreck to occur; therefore, it is necessary to supply something for preventing the overspeeding that is sure to occur when a controller fails.

Automatic engine stops perform a distinct office from that of any control apparatus supplied for an engine; they are intended to stop an engine when the control apparatus fails to prevent overspeeding. Notwithstanding the kind of valve and operating equipment that comprises an automatic stop, which is considered the best that can be procured by those responsible for the installation of them, some fail, and each failure in some measure destroys confidence as to the worth of an make or method however reliable it may be. The assertion has been made by some one, that "accounts of comparatively few flywheel explosions find their way into the press, and that such accidents are occurring at the rate of about 12 a month. Furthermore, authority aserts that there are 33 per cent more flywheel explosions than boiler explosions, and they are 50 per cent more costly."

Any one who has not given exhaustive study to engine stops and demonstrated every feature connected with them, under actual and imaginary conditions, is not able to determine every principle that should be included in the make, installation and treatment required, to insure reliability so far as stopping engines is concerned. There is one supreme principle involved that should always be kept in view, that is, failure from any cause of any part of the installation must result in the stop performing its office, regardless of resultant production loss or any inconvenience. These considerations, namely, loss and inconvenience, are the drawback in too many cases, that interfere with making installations of stops as nearly perfect as human minds can conceive. The most important mechanical principles involved in the construction of automatic engine stops are, quick and positive response to increase of engine speed by that part of the mechanism which makes the initial movement, which can be determined within narrow limits; quick and positive response of the other parts, to contact with the first part brought into action.

Automatic engine stops have been known to fail in the performance of the office they were designed for, because of failure of the agency actuated by centrifugal force to release the static energy held in suspense for bringing a valve into operation, through direct or indirect application of force. Applications through rope, bar or shaft would be direct; through the agency of electric current would be indirect. With whatever design of mechanism employed by principal makers of engine stops, centrifugal force is the prime actuating medium. The agency through which it directly acts, usually a solid of high density, may be located on or in the rim of a flywheel, or a collar attached to a shaft, or on any revolving part where peripheral speed synchronizes with the speed of the engine. It may be indirectly brought into action through a fly-ball governor driven by a belt from a revolving part that moves in synchrony with the speed of the engine.

In the list of failures are cases where connecting pins, placed in the rims of flywheels and actuated by centrifugal force, become rusty or had accumulated matter around them and in the spring for limiting their projection; also from disarrangement of springs that prevented compression or extension of them. In other cases same causes that prevented the action of controllers, accumulation of non-volatile matter, oxi-

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Paper presented before the Twelfth Annual Convention of the A. I. S. E. E.

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dation of metallic parts, pressure of packing, etc., have been the cause of failures. There is not one of these causes but that could have been discovered and guarded against by a systematic inspection and proper construction. Connecting pins placed in the rims of flywheels should be carefully constructed, both spring and pin a loose fit yet not excessively loose. The pocket for the spring should be so large the spring will be free when at the point of utmost compression. Spiral springs should be so coiled that the utmost compression they are liable to be subjected to will not bring the coils together. Periodically spring and pin should be cleaned and oiled.

The shut-off valve of an automatic stop should be so perfect it could not fail to close when released from its fastenings for keeping it open. Probably failure from this cause has done more to shake confidence in automatic stops than any other kind of failure. As all these valves must have exterior connection to their shafts or stems, such shafts or stems must pass through packing, or have a collar that will seat on a bearing to prevent escape of steam. A stem that moves longitudinally is very liable to stick from causes previously enumerated. None but metallic packing should be used to pack valve stems. Cylinder lubricants should be admitted on the intake side of valves. In the case of turbines where there may be objection to admitting grease into steam cylinders, valve stems can be lubricated by admitting the lubricant directly on them in quantities just sufficient for the purpose. In no case should a valve stem point in a line that drops below the horizontal; preferably it should point above the horizontal. When a valve closes with a rotating movement and is actuated through a self-packing shaft, there is but little if any need for a lubricant, as the area of friction surface is small and the actuating force for revolving the shaft is highly compounded.

Fly-ball governors for tripping a latch or breaking a circuit are so sensitive to the force that actuates them, they can be set to trip with a very small increase of acceleration, and a drive for governors can be supplied that is reliable. With reliable drive no condition can arise that will prevent a properly constructed fly-ball governor from performing its office. Breaking of the drive will allow the governor to swing on its mast and trip the latch. With governors as with pins that are projected from rims of flywheels, they should be frequently inspected, but unlike the pins they are always accessible for inspection regardless of whether or not an engine is running. They can suffer considerable deterioration yet be efficient, but there should be no excuse for serious impairment of their parts so that a failure might occur that would unnecessarily stop an engine.

Without atempting to go deep into discussion of the various kinds of stops included in the list that is operated entirely independent of electrical current, it may be said they require the secondary force, that may be brought into action through an initial force, to be considerable, and possibly this may be interfered with. Quoting one prominent maker: "The mechanical is the simplest of our make of engine stops; it is, however, limited as to its possibilities and its use is ordinarily recommended when it is desired to obtain protection from overspeed only, or to shut down the engine by hand from a point no great distance from the engine." The principles involved in an electrically operated engine stop are well known and it is not necessary to go far into details of their construction. The force required for breaking a circuit is insignificant and can be depended on to operate when it should. When the current has been broken the force of gravity, an ever dependable agency, will perform the further office of bringing a stop into action. If any objections raised against one or the other of the two systems can be sustained, the logical solution of the matter would be to install stops that contain a combination of both principles, as is done by some makers and can be done by all of them. The additional cost for installing the combination of methods should be so small as to be inconsiderable and it cannot add complexity without compensation. The method could claim preference because of its wider adaptability, namely, operating by breaking the circuit from a limitless number of stations, and operating because of disarrangement of engine parts or by breakage of them, etc. Among cases where they have proved efficient is, detecting failure in rope drives and stopping engine before results became serious. Further damage was prevented when a fitting in a steam line broke. A case can be cited where the side bearings in a journal box of a large engine became damaged to the extent that a wreck was imminent, and the engine was brought to a stop in time to prevent it, by the automatic stop. It does not require a large exercise of imagination to see where their office can be extended to safeguard from many possible mishaps that would be more serious than stopping a mill even though some or all of the roll passes were filled with material.

Hand-operated, quick-closing valves with omission of the automatic control feature have been installed in some cases. With the exception perhaps of blast engines alone, the omission is not justified since the efficiency of the automatic control feature has been fully demonstrated. While a hand-operated, quick-closing valve permits an operator to shut steam off instantly, he cannot always be depended on to be close enough to a station or he may decide to get further away. Even though it might be thought advisable to install hand-operated, quick-closing valves on blast engines to check the speed within safe limits if necessary—a case where bringing an engine to a full stop is a hazard too great to be permitted—there could be no objections to adding the auxiliary agency of electric current, as for one thing, this gives superior advantages through ability to locate stations in the most desirable places regardless of distance or elevation.

In the installation of stops electrically operated entirely, or with electrical operation for an auxiliary to mechanically operated stops, the matter of using open or closed circuits is one of importance. As the supreme principle involved is, a stop must perform its office regardless of other results, the installation cannot be positive unless the fact that the engine is running is evidence that the automatic stopping equipment is in perfect condition. Quoting different makers of engine stops one firm says, "In many ways the closed circuit system is ideal in the fact that the engine is running, is a guarantee that the electrical system and engine stop are in perfect condition." Another maker says, "It is a well known fact that the most reliable electric engine stops are those operated on the closed circuit principle, for the reason that they are self testing, and any derangement of the wiring system will cause them to operate and shut off steam from the engine." We have seen installations of closed circuit systems in mills where they gave perfect satisfaction, and in other mills where the conditions were exactly the same, open circuit systems were installed. If the closed circuit system was feasible with some it should have been feasible with all. There is much argument that can be offered in favor of the open circuit system yet important questions are not entirely settled by argument alone.

The installation of automatic engine stops on reverse engines that drive two-high mills, aside from their worth for preventing accidents to persons and machinery, are effective from the economic point of view. When such engines are so equipped it is found that the wear and breakage items are much lessened. After they have been installed a short time it will be found they are but seldom brought into action unless for trial to see if they are in good order. A governor for tripping the latch and breaking the circuit cannot be successfully applied on reversing engines. A split collar can be placed on the engine shaft to insert the contact pin in, or the pin can be inserted in the sector shaped counterbalance to the crank and connecting rod. This method has given satisfaction. Objections have been raised against the split collar arrangement on shafts or blooming engines, on the grounds that the trip will operate unexpectedly when the engine is suddenly reversed. No attempt will be made here to account for this action, but perhaps proper investigation would reveal the cause and the defect could be overcome.

The question might be raised that, as the points for consideration in the installation and treatment of controllers and automatic stops are similar in principle, and as the controller must prevent overspeeding, why should two sets of apparatus be installed when observance of the same precautions is necessary in both? In answer we will say automatic stops can be installed so that the engine in motion is a guarantee that the stop is in perfect condition, but in cases where conditions will not permit of this ideal installation we reply by referring to the law of chance governing the average length of intervening time between periods at which simultaneous failures can occur. Ordinarily a controller protects against overspeeding, but from various causes they fail to do this sometimes without giving warning. Automatic stops guard controllers and vice versa, controllers guard stops.

The ideas contained in this paper are either borrowed from the experience of other persons or they came within the author's own observation. We seek to harmonize ideas on an important matter and reduce them to a common and practical basis. The deductions that could be drawn from the paper are: Automatic engine stops are indispensable adjuncts to all kinds of engines that can overspeed and cause a wreck or accident. They are dependable when carefully installed and carefully maintained. Their use probably can be extended to include blast engines, and to the performance of various other offices where they would prevent wrecks. Of several types of installation, any can be relied on to act when required if they are properly constructed and reasonable effort is made to maintain them. When it is considered there are instances where the most primitive make of stops, with some change of construction from time to time as suggested by experience, have been kept constantly in dependable condition as proven by frequent tests, and by responding to demands on them by reason of failure of controller or engine parts, there can be no argument to offer against any of the most modern designs. As the makers are not confined entirely to particular designs that will not fit all conditions, a combination of principles can be made by any of them that will suit any reasonable requirements. In making an installation, consideration should be given to those features that manifestly are the most dependable and will require the least expenditure of care. This in no manner absolves from constant watchfulness and necessary care.

Conclusions from investigation along theoretical lines have been backed by results in practice and all point to an installation that might be classed as ideal, containing the following important features: The valve for shutting off steam should be rigidly fixed to a shaft that would close the valve when rotated; the actuating force for closing should be gravity with the aid of the current of steam flowing into the cylinder. The static force, which when released actuates the valve, should be released by opening a confining

(Continued on Page 410.)

Remote Controlled Sub-Station Described

Motor Generator Sub-station Located About 2,200 Feet from Main Power Station, Feeding 250-Volt Direct Current Transmission Line, Entirely Controlled at Main Power Station.

By W. T. SNYDER.

The original electric power system of the plant to which this paper refers consisted of four 625 kw, 250-volt dc, steam priven units, the power plant being located near the geographical center of the plant. Later there were added two 1,000-kw blast furnace gas engine units in parallel with the existing units. The next addition was a 3,750 kva, 80 p f, 6,600-volt, three-phase, 25-cycle, low-pressure steam turbo-generator, which power is converted to 250 volts, dc by means of three 1,000-kw motor-generator sets.

One of these motor generators is located in the turbo-generator station and is in parallel with the dc transmission line approximately 2,600 feet east of the main power plant bus. The second motor generator is located in the main power station and the other is located approximately 2,200 feet west of the main power plant bus and parallel at this point with the dc transmission line. This latter motor generator set is remotely controlled from the main power station; there being no attendants required, the sub-station being kept locked. The sub-station is visited once a day by an attendant from the main power station and by the meter reader.

The improvement in voltage conditions over the transmission system after locating sub-stations at either end of the main transmission line is shown in Figure 1.

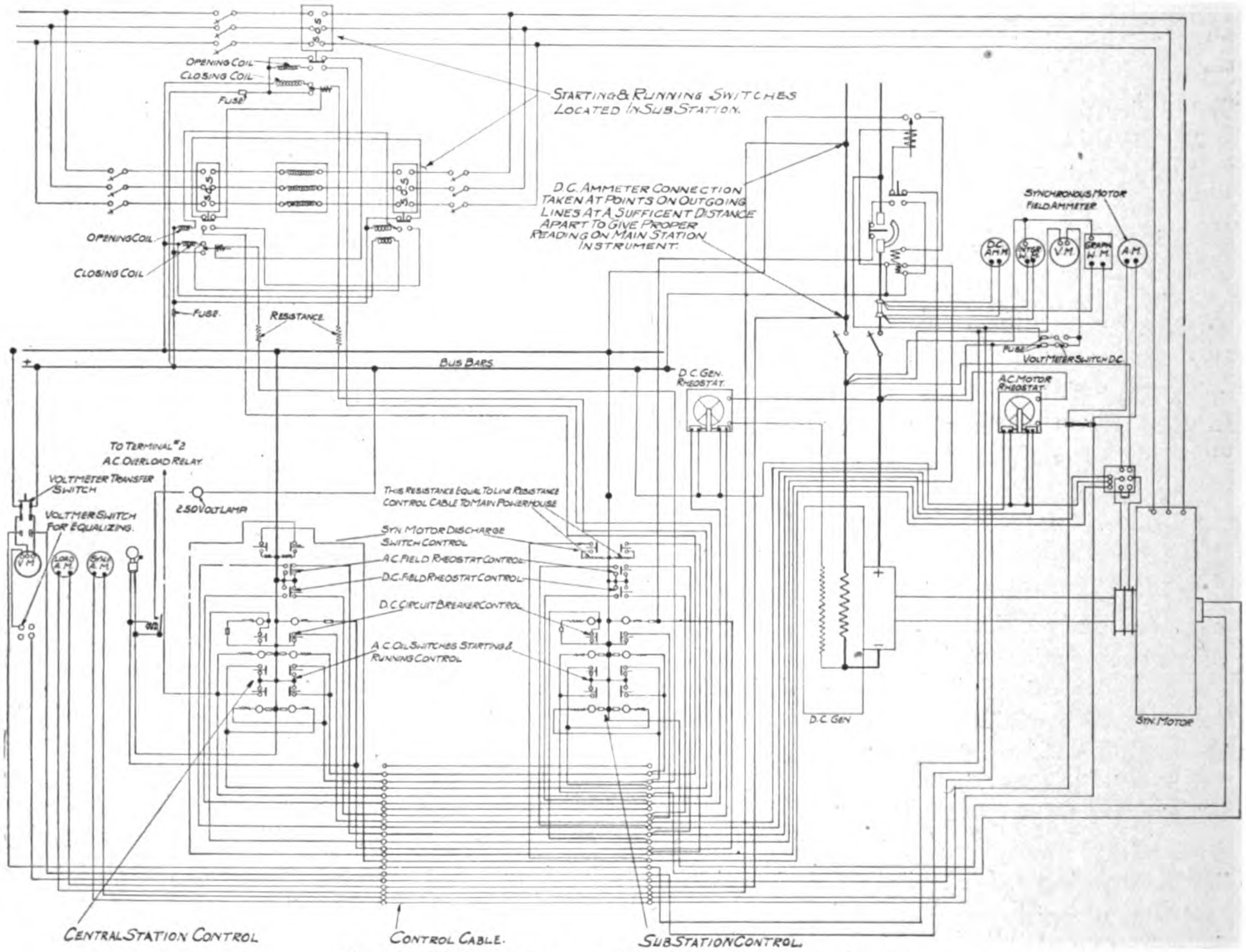
OPENING COIL
CLOSING COIL
FUSE
STARTING & RUNNING SWITCHES LOCATED IN SUB STATION.
OPENING COIL
CLOSING COIL
FUSE.
RESISTANCE
D.C. AMMETER CONNECTION TAKEN AT POINTS ON OUTGOING LINES AT A SUFFICENT DISTANCE APART TO GIVE PROPER READING ON MAIN STATION INSTRUMENT.
SYNCHRONOUS MOTOR FIELD AMMETER
D.C. AMM.
INTGR. W.M.
V.M.
GRAPH W.M.
A.M.
FUSE
VOLT METER SWITCH D.C.
+
BUS BARS
D.C. GEN. RHEOSTAT.
A.C. MOTOR RHEOSTAT.
TO TERMINAL #2 A.C. OVERLOAD RELAY.
VOLTMETER TRANSFER SWITCH
VOLTMER SWITCH FOR EQUALIZING.
250 VOLT LAMP
V.M.
LOAD A.M.
SYN. A.M.
THIS RESISTANCE EQUAL TO LINE RESISTANCE CONTROL CABLE TO MAIN POWERHOUSE
SYN. MOTOR DISCHARGE SWITCH CONTROL
A.C. FIELD RHEOSTAT CONTROL
D.C. FIELD RHEOSTAT CONTROL
D.C. CIRCUIT BREAKER CONTROL
A.C. OIL SWITCHES STARTING & RUNNING CONTROL
+
−
D.C. GEN
SYN. MOTOR
CENTRAL STATION CONTROL
CONTROL CABLE.
SUB STATION CONTROL

Fig. 2—Wiring diagram of main and control circuits.

The dotted lines in Figure 1 show location of proposed installation of one 1,500-kw motor-generator sub-station and one 3,000-kw motor-generator sub-station. These sub-stations will be located at centers of load intermediate between present sub-stations and the main power plant and both will be remotely controlled from main power station.

The cost of a remotely controlled sub-station of the type described is approximately 10 per cent greater than

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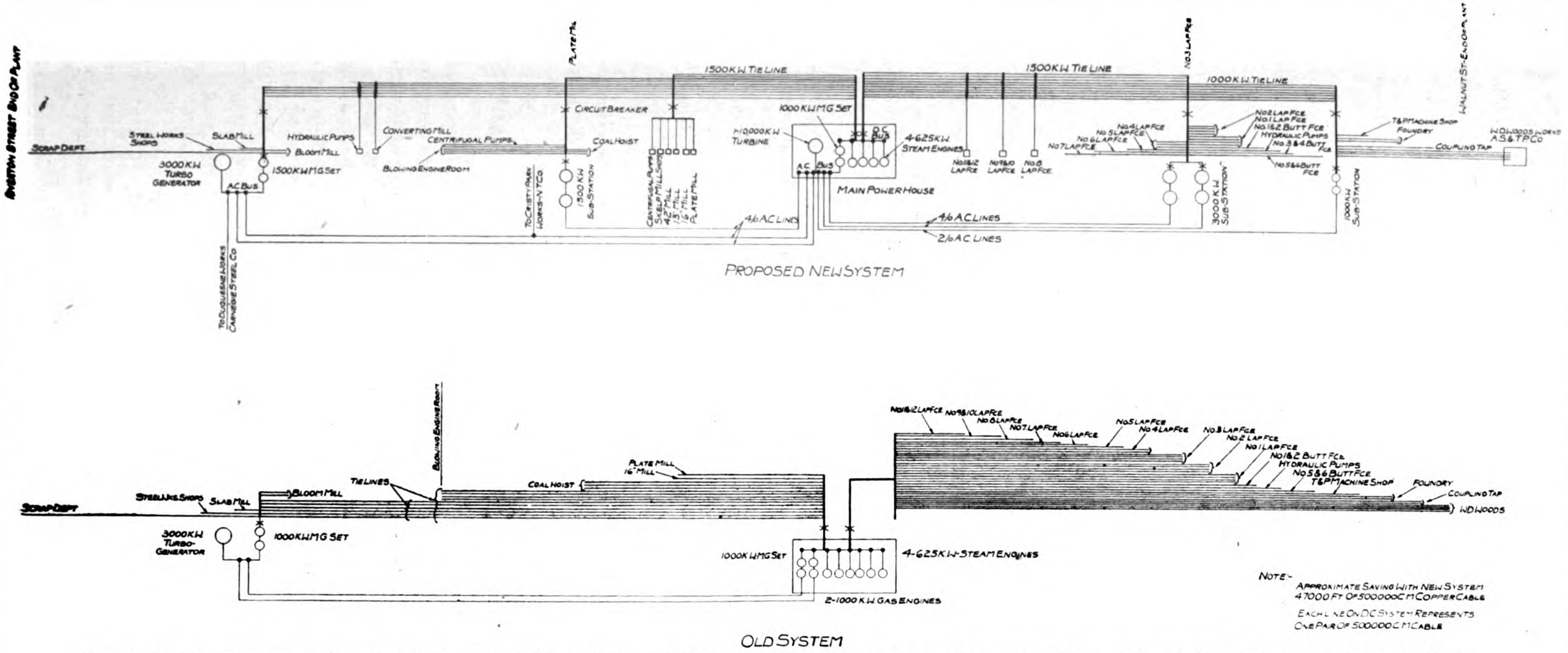

Fig. 3—Simple diagram of the a.c. and d.c. generating and transmission systems, without sub-stations, as well as with existing and proposed sub-stations.

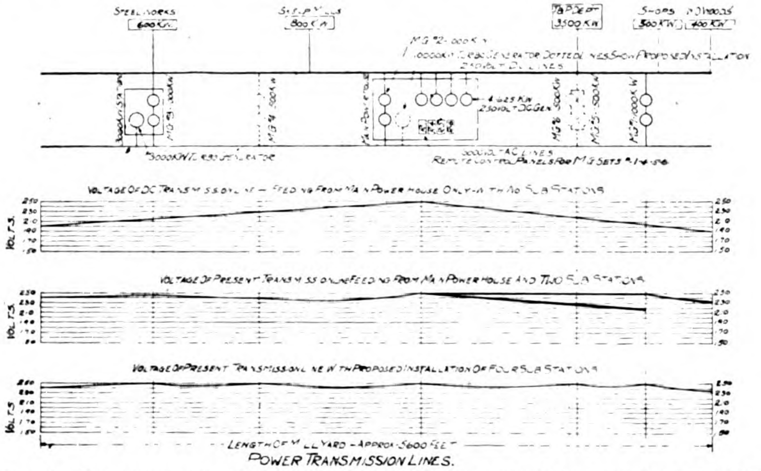

Fig. 1—Improvement in voltage conditions over transmission system after locating sub-stations at either end of main transmission line.

the cost of a manually operated sub-station. This additional cost is returned each year in the saving effected by eliminating the need of attendants.

One of the items in the cost of a remote-controlled sub-station which is not present in a manually-operated station is the control cable between the main station and the sub-station which is used for switch apparatus, connection to signals, etc. The cost of this item will vary with the distance between the control station and the sub-station. The control cable between main station and sub-station is composed of 25 pairs, No. 19 Brown & Sharp gauge, copper wire, 6,000-volt insulation with lead covering.

The additional equipment required for each machine for remote controlled substation compared to that required for sub-station with attendants is given herewith:

Substation with Attendants	Remote Controlled Substation
Lever operated oil circuit breakers. (Starting and running.)	Solenoid or motor operated oil circuit breakers (starting and running.)
Lever operated dc circuit breakers. (Generator.)	Solenoid or motor operated dc circuit breakers. (Generator.)
Not required.	Two control panels. One in sub-station and one in main power station.)
Not required.	Lead or steel covered 600-volt signal cable between main station and sub-station for starting, stopping and regulating motor generators.
Hand wheel rheostats.	Solenoid or motor operated field rheostats (one for motor and one for generator.)
One dc ammeter at sub-station.	Duplicate indicating dc ammeters. (One at main station and one at sub-station.)
One parallening volt meter at sub-station.	Duplicate paralleling voltmeter. (One at sub-station and one at main station.)
Lever type field discharge switch for synchronous motor.	Solenoid operated field discharge switch for synchronous motor.

The complete bill of material for control apparatus for sub-station described is as follows:

Material.	Amt. required	Description.
Cable	2,250 ft.	2/0, 3 conductor, lead, steel armored cable.
Joints and end bells	2	2-Straightway, 3 conductor, cable joints and joining material and 3 end bells.
Cable	100 ft.	2/0 lead covered cable.
Cable	4 reels	⅛" Messenger wire.
Cable	4 reels	⅝" Messenger wire.
Cable clips	2,250	Aerial rings.
Cable	2,085 ft.	25 pairs, control cable—lead covered, paper insulated.
Cable	875 ft.	2-million circular mill cable.
Cable clips	2,250	8" long.
Insulators	72	Giant strain.
Switchboard	1	Consisting of two panels, one control panel and one generator panel.
Terminals	2	Hard rubber terminals. (For control cables.)
Switches	4	Twin pull button control switches, with indicating lamps.
Switches	4	Twin pull button control switches, without lamps.
Switches	4	Pull and push button control switches.
Rheostat Devices	2	Solenoid operated ratchet device, for operating field rheostats.
Switch	1	D. P. D. T. solenoid, operated discharge rheostat switch.
Switches	12	Disconnecting switches.
Oil switches	3	Single phase, 15,000 volts, 300 amp., S. P. S. T.
Oil switches	2	Three phase, 15,000 volts, 300 amp., T. P. S. T.
Compensator	1	6,600-3,300 volts.
Switches	9	Disconnecting, 15,000 volts, 300 amps., S. P. S. T.
Meter	1	6,000 amp., watt hour meter.

The sequence of operation to put the sub-station on line, with machine at rest, is as follows:

a—Positive and negative generator switched (lever type) always closed except when machine is to be off for a long period, such as week end.

b—Start synchronous motor in usual way by means of remote controlled oil circuit breakers, remote controlled rheostat, and remote controlled field switch.

c—Equalize dc voltage by means of remote controlled, solenoid or motor operated, field rheostat.

d—Put dc generator on line by means of remote controlled, solenoid or motor operated, single pole circuit breaker. (This circuit breaker is equipped with overload and reverse current relays, bell alarm contacts with bell in main power station and indicating lamps and signals on pull switch at main station. Circuit breaker is actuated through relay so that current of circuit breaker operating coil is not handled in control wires between main station and sub-station.)

e—Adjust load on dc generator by means of remote controlled rheostat.

f—Adjust field of synchronous motor by means of remote controlled rheostat.

To operate the indicating ammeter in main station, taps for meter leads were taken off power cables at a sufficient distance to give 220 m. v. drop at cables and 200 m. v. drop at meter. (Three pairs of the control wires are paralleled for this connection between sub-station and main station.) Resistance is inserted at meter to give 50 m. v. at meter terminals.

Wiring diagram of main and control circuits is shown in Figure 2.

A simple diagram of the ac and dc generating and transmission systems, without sub-stations, as well as with existing and proposed sub-stations is shown in Figure 3.

The remote controlled sub-station described was put in operation September 14, 1917, and has been in regular and successful operation since.

Characteristics of Automatic Engine Stops.

(Continued from Page 407.)

lock and the static force, which when released opens the lock should be gravity and released by breaking a feeding circuit for energizing a magnetic coil. Centrifugal force should be the actuating agency for releasing the lock by direct application or by breaking the circuit that energizes a magnetic coil, permitting gravity to open it. The agency actuated by centrifugal force could be either a fly-ball governor, adjusted by a spring or gravity to speed requirements, or a contact pin adjusted by a spring.

Any arrangement that is intended through operation in conjunction with any parts of the regular mechanism of an engine, either for admission of steam into cylinders or controlling the admission of steam to regulate speed, has somewhere a feature that breaks the chain of continuous reliability.

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Standardizing Large Rolling Mill Motors

Difficulties of Users of Large Rolling Mill Motors Due to Difference in Manufacturers' Rating—Suggested That Motors Be Rated on Continuous Capacity at Some Particular Temperature.

By K. PAULY.

During the developmental period of anything, whether it be a device or a method of doing something, there is often, and perhaps I should say almost always, a period during which the producers differ materially from each other, concerning some of the essential details, in their efforts to give the users a product which best meets their requirements and to properly define it by name. With experience comes the crystallization of ideas. The views of the producers become more and more alike and they soon find themselves in a condition to "get together" on a common basis compromising their differences to satisfy a demand on the part of the users, as well as from within their own organizations, for standardization. It is at this point in the evolution of the main roll motor, that we find ourselves today.

Standardization of the capacities of main roll motors, in the sense of the ordinary interpretation of the term "standardization," can hardly be carried out because of the wide variations in speeds and frequencies required for each size of motor, but you will all agree with me that no serious difficulties stand in the way of the standardization of the name or rating of these motors and this paper will be confined entirely to a discussion of this phase of the general subject.

Before discussing the subject let us consider for a moment what we expect to accomplish. Why standardize the rating of these motors?

First, the standardization of ratings will materially assist the mill engineer. All those upon whom the responsibility of determining the proper size of a motor to be applied to any given mill to produce a specified tonnage, appreciate the advantages of, as well as the assurance afforded by, a comparison of their estimate with the capacities of motors applied elsewhere under the same or similar conditions. Obviously unless the ratings are all on the same basis, any such comparison may lead to costly mistakes unless the difference in methods of rating are thoroughly understood, which is seldom the case, or a more or less exhaustive test or series of tests are made to determine the actual load on the motor which is being used for comparison.

Second, the work of the purchaser's engineer and purchasing agent are greatly simplified if they can eliminate the time required to reduce all the ratings to the same basis, a task which is well-nigh impossible without disclosing competitor's specifications among the bidders because of the absolute lack of sufficient data and experience. It has been my experience that, next in importance to omissions, differences in methods of rating are responsible for the price differences among competitors.

Third, the standardization of ratings will tend toward the standardization of capacities, and while the gains in this direction may be small they are in the right direction and may have a material effect in reducing the prices and shortening the deliveries in some cases.

The objections raised to a single standard of rating are usually psychological and frequently purely imaginary. I have emphasized single because it has been my experience that frequently enthusiasm for standardization is conditioned on the adoption of a particular standard and that this enthusiasm often vanishes, and may even become opposition, if an entirely different or even compromised standard is proposed. One becomes acustomed after long experience to a method and hesitates to change. Difficulties which are mere molehills loom up like mountains to be overcome in adapting one's self to the new conditions. So in considering this question, let us avoid placing undue importance on more or less trifling differences between the old and the proposed new method and recognize that some effort, perhaps considerable on the part of a few, will be necessary for adapting ourselves to the new conditions and, recognizing the advantage of standardization, be willing to make it.

Before offering for your consideration any particular standards, it is well to consider for a moment what characteristics in a motor determine its ability to meet rolling mill conditions. Having established these, the standardization of the rating is reduced to a comparatively simple problem. Tonnage from the steel producer's standpoint is the most important consideration and our rating must be such as will indicate the capacity of the motor to produce steel.

Now three factors, viz., reduction per pass, peripheral speed of the rolls and total idle time, that is, intervals between passes together with time between successive ingots, affect the tonnage. By an assumed adjustment of these variables with relation to each other, any one may be varied between wide limits

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without affecting the capacity of the driving motor, but we are not free to manipulate all of these variables, in fact one or two and frequently all are fixed by rolling practice. Recognizing this we may make the following general statements:

The maximum loads are increased by increasing the reduction or speed, or both, but are not affected by changes in idle time. The tonnage output of the mill and the root mean square value of the load cycle increase with increased draft or speed, and decreased interval between passes and ingots. The root mean square value of a load cycle determines the continuous capacity of the motor capable of performing the work represented by the continued repetition of the cycle, and, as the root mean square varies directly as the tonnage, the continuous capacity of a motor may be taken as a measure of the capacity of a given machine to produce tonnage. Obviously, the overload capacity of any motor must be equal to or greater than that required by the duty cycle.

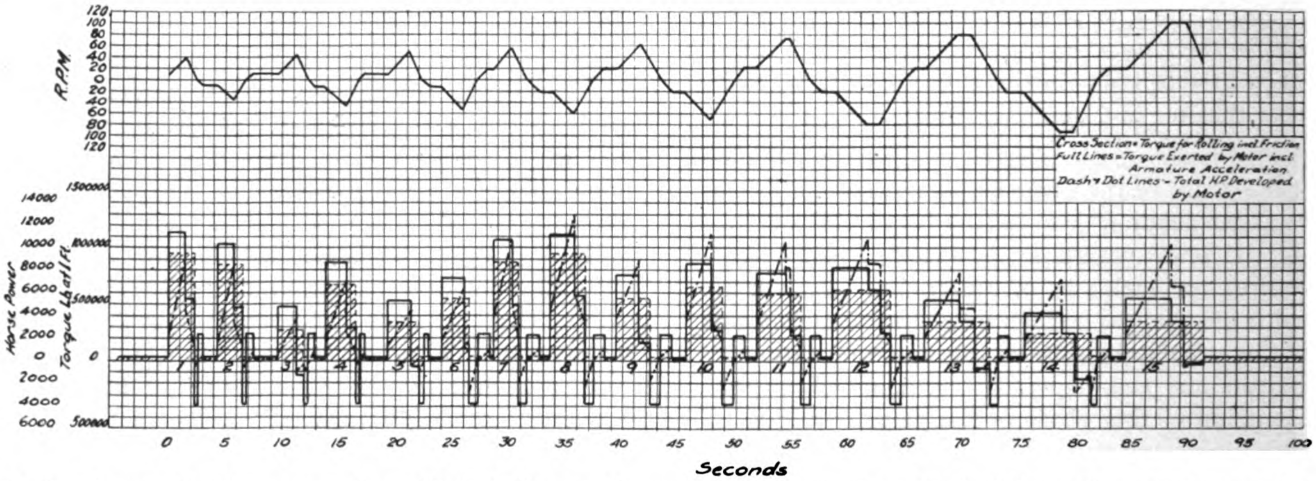

Fig. 1—Load curve for large reversing mill, including work required to accelerate and retard the motor armatures and power for rolling.

Fig. 1, which is the load curve for a large reversing mill and includes the work required to accelerate and retard the motor armatures as well as the power for rolling, will serve to illustrate these facts. Assume any changes in the curve which will result in increased tonnage and the r.m.s. of the curve will increase correspondingly and vice versa. The peak, however, can be increased by increasing the speed or by any other means and, by increasing the intervals between passes, the tonnage and r.m.s. may actually be reduced.

Therefore, to properly define an equipment to meet any given rolling cycle, we must state its every ingot maximum momentary capacity, i. e., the maximum momentary load which can be repeated one or more times for each ingot as is required to meet the normal load cycle, its emergency maximum momentary capacity at infrequent intervals to take care of variations in draft and temperature of the steel, or any other factors which may occasionally produce peaks greater than the root mean square value of the load cycle if the continuous capacity which must be equal to or greater than the root mean square value of the load cycle if the equipment is to be capable of producing the specified tonnage.

For our purposes it is unnecessary to consider the effect of these limiting requirements on the design of rolling mill motors further than to state that either the continuous or the maximum momentary capacity, depending upon their relative values, may determine the machine. Accepting this, which I think you will all admit is substantially correct, a machine may be rated by either the capacity which it will carry continuously or the maximum capacity for a specified time, which latter rating must be equivalent, from the standpoint of heating to the rolling load cycle. Obviously, it is not necessary to include both the continuous and the maximum capacities in the rating, but a statement as to the one not included in the rating should appear in the specifications, and the question immediately arises which best serves our purpose in the rating. To be of real value, our rating must be such that it can be easily reproduced for test purposes with as little as possible left to the judgment of the engineer making the measurements. It must not be subject to carying interpretations by different engineers.

Reproducing local conditions is perhaps the ideal way to test the fitness of a machine, but you all readily appreciate that this is not practical in advance of its being installed on the mill and, even then, it is very questionable whether actual contract conditions can be reproduced should there be a difference of opinion as to whether the contract obligations had been met. If the maximum capacity is to serve as the basis of rating we must, as previously stated, also include the time during which this load is applied continuously or intermittently (one minute on and one minute off) to be equivalent to the rolling cycle from the standpoint of heating.

In rolling, the maximum loads are of momentary duration only and can only be applied for short periods in any demonstration test, as otherwise the insulation next to the conductors will become injured before the heat can be conducted away and before the external temperature indicates dangerous heating.

With induction or synchronous motors, except for the extreme difficulties of making tests involving such very large powers as those with which we are concerned, the intermittent maximum load method might serve our purpose, assuming that the loads are not applied, without interruption, sufficiently long to injure the insulation, and that the cycle is equivalent to the normal rolling cycle. For direct-current motors and alternating-current commutator motors, testing by the intermittent application of the maximum load is too severe a test of the commutation.

Reference to the load cycle shown in Fig. 1 will make this point clear. The heating equivalent (rms) of the cycle is approximately 5,600 h.p. Testing by the equivalent intermittently applied maximum load (13,000 h.p. 30 seconds on and 134 seconds off) requires the motor to be subjected to its maximum load 660 seconds out of every hour, while, in the actual performance of its work, the motor will be called upon to deliver its maximum power, only 74 seconds out of every hour, with overloads greater than 8,500 h.p. for only 800 additional seconds per hour which is obviously considerably less severe than our proposed test. Therefore, rating by maximum load is hardly commercial for either a-c. or d-c. motors and questionable even as a technical possibility for commutator motors, either a-c. or d-c.

Eliminating the maximum capacity as a basis of rating, there appears but one other, viz., the continuous capacity with a given temperature rise which is at all suitable for our purpose. As previously pointed out, however, the continuous capacity, without a statement as to the maximum capacity, does not necessarily indicate the fitness of a motor for a given rolling cycle, but the overload capacities can better be made a part of the descriptive specifications, as do the efficiencies, etc., than to complicate the rating by including them.

The advantages of the continuous capacity of a machine as a basis of rating are so well recognized that it is unnecessary here to discuss them at length but briefly stated they are: simplicity, definiteness, ease of understanding and reproduction by test.

The rating, which is merely the output marked on the name plate, should bear the same relation to the continuous capacity for all machines, if it is to serve as a means of comparing different equipments.

Obviously a rating equal to the continuous capacity as defined by the A. I. E. E. in paragraph 261 of the December, 1916, edition of the standardization rules fulfills all the requirements of our specification covering rating and, for the purpose of discussion, I offer the suggestion that we adopt such a rating as our standard. Doing so will simply be adopting the A. I. E. E. standard for our standard. The suggested ratings follow:

Constant A-C. and D-C. Motors.

The rating shall be the continuous capacity with a temperature rise not exceeding the temperature limits prescribed by the A. I. E. E., 1916 edition of standardization rules. (See paragraphs 375 to 392 inclusive.) Efficiency and power factor guarantees shall be based on this rating.

Adjustable Speed Reversing and Non-Reversing A-C. and D-C. Motors.

The rating shall be the continuous capacity with a temperature rise not exceeding the temperature limits prescribed by the A. I. E. E. standardization rules (see paragraphs 375 to 392 inclusive.) Efficiency and power factor shall be based on this rating and given for maximum and minimum rated speeds.

General.

When forced ventilation is used the specifications shall state the number of cubic feet of air required per minute and that the temperature guarantees are contingent upon this specified amount of air being passed through the machine.

As to the need for the standardization of the ratings of our large motors, I believe we are unanimous and I am optimistic as to the possibility of our ultimately arriving at some satisfactory basis for these ratings, but as the standards committee of the A. I. E. E. after careful consideration of all the factors have adopted the standards suggested above, our logical step is to endorse them.

From the manufacturers' standpoint the standardization of one temperature is the important consideration, whether it be 35 deg. C., 40 deg. C or 50 deg. C., but, as the adoption of any one of these as our standard simply involves adapting ourselves to it, why should we not follow the recommendations of the A. I. E. E.?

One of the most important reasons given in justification of the use of the lower temperature rating is that a motor so rated contains considerable margin which may be utilized either to compensate for an error or to take care of the increased production which is so frequently required shortly after a mill is put in commission. If this margin in capacity of rolling mill motors is desirable, and I believe steel mill operators and engineers are practically unanimously of the opinion that it is, the interests of the purchaser are better served by increasing the capacities of his motor 25 or 30 per cent above his estimates of the powers required to meet his immediate needs and purchasing motors of these capacities for 50 deg. C. rise than by specifying motors of his estimated capacities for 35 deg. C. or 40 deg. C. rise.

The reason for this is very simple. From 5 to 15 per cent more output at 50 deg. C. can be obtained from the same material if the motor is designed as a 50 deg. motor than if it is designed for a rating at 35 deg. C. or 40 deg. C. and operated at an overload. It will also operate at as good or better average efficiency on a rolling mill cycle, which is made up largely of overloads and rest periods, as its efficiency is higher at the overloads due to the better balance between its fixed and variable losses. The break-down torque, frequently a limiting feature of design, will be higher, which, if it is desired to take full advantage of the 50 deg. capacity, may be a serious handicap of the lower temperature rated motor.

In reply to the one who is asking the question "why not design your motors for 50 deg. C. and rate them at 35 deg. C. or 40 deg. C.?", I am compelled to say that, unless you adopt some system as the basis of making guarantees which is the equivalent of rating your motors at 50 deg. C., you cannot bring this about. Efficiencies and power factors play an important part in the sale of motors, and, to make the best showing, the design of a motor must be based on its rating. Obviously you can call for guarantees based on a specified overload capacity but this is only an evasion of the question.

Not long ago a member of this association called for bids on a motor of a certain capacity capable of carrying 25 per cent overload continuously with 35 deg. rise and I believe with a 50 per cent overload guarantee also. If the power requirements were such as to require a motor anywhere near the capacity which the low temperature specification would indicate was necessary, the purchaser obtained a poorer motor for the work and probably paid more for it than he would have had he increased his rating to that corresponding to either the 25 per cent or preferably 50 per cent overload. While the conditions surrounding this transaction were unusual, the specifications as radical as there are rare, yet the 25 per cent overload continuous capacity with 50 deg. C. rise, which is so frequently called for is of the same type, although of a different magnitude, and might better be taken care of by rating the motor at the overload and temperature.

As pointed out earlier in the paper, the manufacturer is chiefly interested in the standardization of some rating, and my desire in these last paragraphs has been simply to present the advantages in favor of the A. I. E. E. rating from the purchaser's and user's standpoint. We should not take any hasty action; on the contrary, the importance of this question warrants a thorough consideration of all the factors affecting it, and in closing I simply wish to repeat the suggestion which I have already made that, if conforming with the A. I. E. E. standards of rating simply involves a readjustment of our viewpoint, we endorse the A. I. E. E. standards and make the necessary effort.

Problems of Steam Cylinder Lubrication

Causes and Prevention of Troubles Arising from Boiler Conditions — Factors Affecting the Operation and Lubrication of Compound Engines — Special Cases Considered.

By W. F. OSBORNE.

PART III.

Practically all steam from the steam generating drums or tubes of a boiler contains a percentage of moisture and unless subsequently superheated, will reach the cylinder in a wet condition. Moisture in the steam has the effect of washing the oil off the valves and cylinders, decreasing or completely destroying the lubricating film. To offset this destructive action of water the oil must have certain characteristics, such as a greater natural adhesiveness, or must contain some material which will provide lubrication after the water has washed off the oil. To meet these conditions a certain amount of animal oil is added to the cylinder oil, which upon coming in contact with water saponifies and lubricates the cylinders. The percentage of animal oil required depends upon the amount of water present, but usually ranges from 3 to 12 per cent.

Many boiler plants use water for boiler-feed purposes which contains such quantities of mineral substances that very serious scale deposits would be formed in the boiler if the water were not treated. The boiler compounds ordinarily used contain soda ash or lime, both being strong alkalis. Comparatively dry steam carrying a low percentage of water from the boiler removes only a very small amount of the compound from the boiler, while the addition of freshly treated boiler water gradually increases the amount of compound present in the boiler until it reaches the point at which foaming or priming occurs. This, of course, causes large quantities of water highly saturated with the alkali to be carried along with the steam through the lines to the engine. This water containing lime, magnesia, soda ash, silica, boiler scale, etc., has a very bad effect on the oil film covering the valves and cylinder walls, and where such conditions exist it is necessary to use large quantities of highly compounded oil, specially manufactured to resist this destructive action. Sometimes an examination of the cylinder will show no indication of oil at all and the surfaces will be rough and, frequently, rusty if the engine has been standing a short time.

Constant and careful attention should be given to the cause and prevention of such troubles wherever possible. Boiler foaming and priming may be reduced by more careful regulation of the introduction of boiler compound and by frequent blowing down of the boiler to prevent the salts from becoming sufficiently highly concentrated to cause priming. Boilers equipped with suitable dry pipes or steam domes have a less tendency to prime than where these are not provided. Some boilers where steam is taken from the center drum, may be greatly improved by changing the steam outlet to the rear drum and forcing the steam from the center to the rear drum. This will greatly decrease the amount of moisture in the steam and consequently improve the lubricating condition of the cylinder.

Separators of efficient design and ample capacity to remove the water carried, by the steam from the boiler and the condensation in the steam pipes, placed near the engine, will improve the lubricating conditions in the cylinders even when serious conditions prevail at the boiler plant. Sometimes engines are placed at the end of long steam lines which, although covered with good insulating material, will, nevertheless, radiate heat sufficiently to permit of considerable condensation, and separators installed in the proper place to prevent this water reaching the cylinder will serve the purpose of saving the oil film from destruction, prevent the danger of the cylinder head being knocked out, and generally improve the efficiency of the engine.

In general unfiltered straight run steam refined cylinder oils, compounded with the proper percentage of animal oil form the best water resisting cylinder oils. Filtered cylinder oils have not the adhesiveness to enable them to stick to the cylinder walls properly under such severe conditions.

Having discussed the effect of moisture on the lubricating oils, we are now in position to take up the compound engine. The purpose of a compound engine consisting of two or more cylinders is to permit of a large steam expansion without excessive condensation. The high pressure cylinder prevents practically the same lubricating conditions as that of any simple engine except that, in general, the exhaust pressure is higher and the cylinder dryer. Many times the cylinder and inlet valves of a simple engine will be perfectly lubricated but the exhaust valves will groan and stick because the condensed steam has washed off the oil. The steam from the high pressure cylinder passes into a receiver where a large part of the steam which has been previously condensed by the expansion process in the high pressure cylinder is removed through traps. This water of condensation carries with it the liquid oil and the oil washed from the high pressure cylinder walls, together with any saponified oil. The steam then goes to the low pressure cylinder at a reduced pressure carrying with it the uncondensed atomized oil from the high pressure cylinder, which helps to lubricate the valves and cylinders, though it is usually necessary to add more oil in the valve chest or the pipe coming from the receiver to give sufficient lubrication. Because the steam going to the low pressure cylinder is much cooler and usually much wetter than the high pressure steam, it is sometimes advisable to use an oil which will break up more quickly under the lower temperatures, especially where high economy is desired. This is particularly true where the receiver pressure is only a few pounds or even below atmospheric pressure. The more complete the atomization of the oil before it enters the high pressure cylinder the greater will be the benefit accruing to the low pressure cylinder and the more economical will be the oil consumption.

Among the conditions of operation which affect the quantity and character of the oil are the speed of the engine, the load variation and length of time the engine is run between shut downs. The speed of the engine primarily affects the quantity of oil necessary to lubricate the cylinders, and secondly affects the atomization of the oil through the change in the velocity of the steam at the point of oil introduction. A steady uniform load seldom requires a change in the amount of oil fed or an adjustment of the lubricator and the supply may be reduced to a minimum with little danger of damage to the cylinder. A widely variable load, such as rolling steel, however, imposes very severe conditions on the lubricant, as a sudden draft of steam, frequently accompanied by water may find the cylinder wholly unprepared and it is always necessary to use enough oil to meet the extreme conditions which, of course, causes a considerable waste of oil on light loads. Compound condensing engines are particularly susceptible to lubricating difficulties in the low pressure cylinder and in the exhaust valves, where loads are variable. If the engine is shut down for a few hours at irregular periods, with a small amount of steam blowing through the cylinders to keep them warm, it is usually advisable to pump some oil into the cylinder by hand, just before shutting down and again just before starting up, as the steam blowing through the cylinder is likely to dry up all the oil deposited during the usual running time.

A well lubricated cylinder, upon examination, will present a highly polished surface, free from rough spots, and will vary in color from a light silver to a gunmetal blue. The oil film at the top, bottom and sides should be thick enough to penetrate from three to six thicknesses of "Rizla" cigarette paper, which is suggested because of its uniform thickness. If the stain on the paper is not of a light brownish color, but is blackish or shows up dusty, it generally indicates that the oil is carbonizing or that the surfaces are not properly lubricated and are wearing. Sometimes it may be the cylinder which is being worn and again it may be the piston rings, but, in any event, a careful examination should be made to determine and remove the cause of the trouble. If bright streaks of a lighter color than the remainder of the cylinder appear, it is quite possible that the piston rings are scratching the cylinder or that some gritty substance, such as boiler scale, is getting into the cylinder. Care should be taken to examine the cylinder as soon as possible after the engine is shut down, as some cylinder oils have a tendency to quickly evaporate making it impossible to determine the quantity of oil appearing on the cylinder walls when the engine is actually in operation.

Deposits in the counter-bore valve and other parts of the cylinder may be due to excessive oil consumption or to boiler scale and boiler compound, held together with a small amount of oil.

Lack of lubrication may be quickly observed when the engine is running by the groaning and sticking of the valves, and may be due to a great many things which should be carefully investigated and the cause removed. Sticking of Corliss valves may be caused by a sudden shot of water washing the oil off and causing them to run dry. The valves may also stick from some defect of valve gear and dash pots, or because of a mechanical defect in the valve or seat.

In addition to lubricating the cylinder and valves of a steam engine, oil properly introduced into the steam and efficiently atomized will also lubricate the throttle valve stem and automatic safety shut-off valve, preventing rust and keeping the valves in good condition. The oil in the steam will also lubricate the piston and valve rods just as well as it lubricates the cylinder, and if the packing is properly put in and kept up, without being drawn up excessively tight, no additional oil need be fed on the rods outside of the stuffing box. It is sometimes necessary, however, to feed additional oil to prevent scoring of the rod, if the carbon packing is used, particularly when it rubs very tightly on the rod.

Special classes of steam cylinder lubrication require special lubricants, some of the most important of these being marine engine, steam pumps, refrigerating plants and plants where the exhaust steam is used for boiler feed or manufacturing purposes.

Steamships on salt water invariably use the condensed steam for boiler water make-up and as it is essential to the safe working of the boilers that no oil gets in them, the cylinders are usually run without any oil at all being fed into them, depending solely upon the moisture in the steam lubrication. Oil is used, however, for swabbing the rods, and a small quantity naturally works into the cylinder. For this reason a pure mineral oil is used, as it may be removed from the steam by the use of proper oil-separating devices.

Although the same method is employed in lubricating steam pump cylinders as for steam engine cylinders, the operating conditions are somewhat different owing to the intermittent operation. Elevators, boiler feed, tank well pumps, etc., are usually controlled by an automatic regulator placed on the discharge side of the pump by which the speed of the pump is controlled. When the pump is shut down, the condensation which takes place in the steam line has a great tendency to wash the oil from the cylinder walls when the steam valve is opened by the regulator, and, on this account, the oil used must be of such a nature as to resist this washing action. Oils highly compounded with animal oil usually give the best results.

If the condensed steam from the engines is used for the manufacture of ice, great care should be taken that all oil is thoroughly removed from the water. Oil in the water will cause a yellowish porous formation in the ice which is very objectionable, particularly where the ice is used for drinking water. While all such ice plants are equipped with an oil extractor, the majority of these devices are not capable of completely removing any oil except a pure mineral cylinder oil. It is therefore advisable not to use compounded cylinder oils unless absolutely necessary. Even mineral oils should be used in very small quantities. The same difficulty is experienced in plants where the exhaust steam comes in direct contact with the product or is used for boiler-feed water, and it is usually necessary to use a straight mineral cylinder oil.

Many kinds of oils, greases and other substances have been placed on the market to meet the various lubricating requirements of steam cylinders. The oil most widely used prior to the present petroleum oils was tallow oil which was heated in a tallow pot on the top of the cylinder and poured in. With the improvement of petroleum oils, the use of tallow rapidly decreased, and is now practically unknown except in compound with petroleum oils. Petroleum cylinder oils of a high degree of perfection are now manufactured and are undoubtedly the most efficient and economical cylinder lubricants.

Electrically Driven Mills at Bethlehem

Layout, Equipment, Power Consumption and Tonnage on Eleven Installations at the Lehigh Plant of the Bethlehem Steel Company, Using General Electric Induction Motors.

By J. T. STURTEVANT.

In this paper the writer will make no attempt to show any comparison between electrical and steam driven mills, it is intended rather to show the layout, equipment, power consumption, tonnages, and capacities, of 11 installations at the Lehigh plant of the Bethlehem Steel Company.

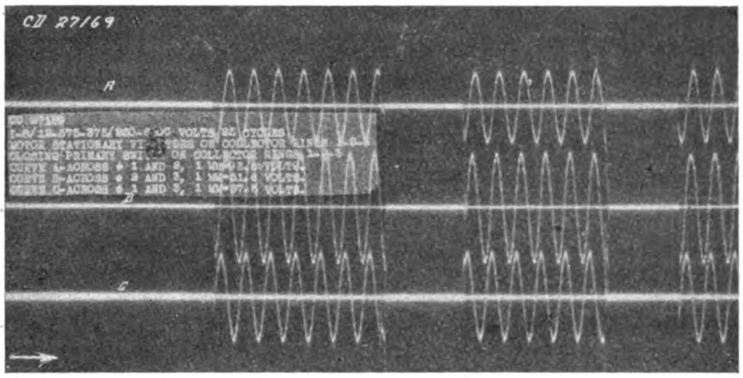

Fig. 1.

Figure 3 shows the layout, motor sizes, speeds and maximum sections rolled on our 8, 10 and 12-inch merchant bar mills. The 10-inch mill was started up in July, 1915, and to April 30, 1918, had rolled 5,077.80 tons of light file special size and shape stock at an average of 85.5 kw-hours per ton. The drive on this mill has given practically no trouble except that crowding the mill at times has cut the brass thrust plate to such an extent that new plates had to be replaced and new oil placed in the bearing. I mention the change of oil because on our entire lay-out of drives this is the only case since installation that a change of oil was made. The monthly record on this mill is 1,516.12 tons. The 12-inch mill was started shortly after the 10-inch and has a monthly record of 3,045.56 tons at 38.4 kw-hours per ton. To this figure of 38.4 an additional 24.5 must be added for the 16-inch roughing mill, which is part of the 12-inch equipment. Which means that a tonnage of 3,045.56 finished product was rolled from 5½ by 5½-inch stock at the rate of 62.9 kw-hours per ton.

The roughing mill is the only mill in Figure 3 which has a fly wheel, its weight being 65,840 pounds. Our 8-inch equipment up to six months ago gave us quite some rotor trouble, repeated break-downs occurring between phases and to ground caused us to take oscillograms which showed the cause and suggested the remedy.

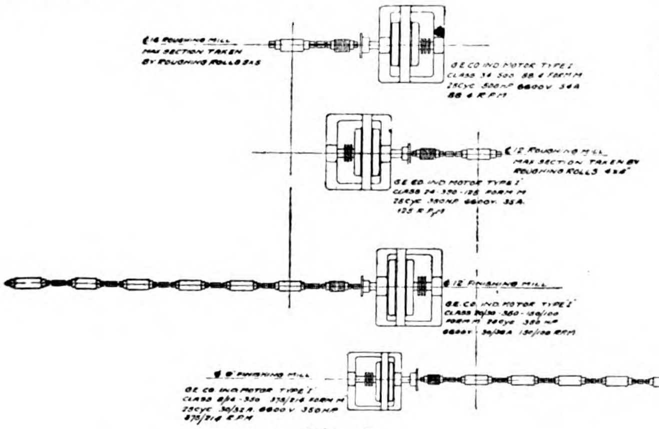
℄ 16 ROUGHING MILL
MAX SECTION TAKEN BY ROUGHING ROLLS 5x5
G.E. CO. IND. MOTOR TYPE I
CLASS 34-500-88.4 FORM M
25 CYC. 500 HP 6600 V 34 A
88.4 R.P.M.
℄ 12 ROUGHING MILL
MAX SECTION TAKEN BY ROUGHING ROLLS 4x4"
G.E. CO. IND. MOTOR TYPE I
CLASS 24-350-125 FORM M
25 CYC. 350 HP 6600 V 35 A
125 R.P.M.
℄ 12" FINISHING MILL
G.E. CO. IND. MOTOR TYPE I
℄ 8" FINISHING MILL
G.E. CO. IND. MOTOR TYPE I

Fig. 2.

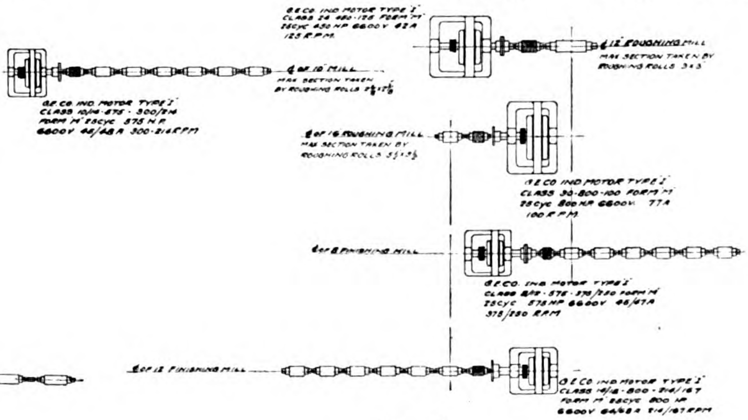
G.E. CO. IND. MOTOR TYPE I
CLASS 24-450-125 FORM M
25 CYC. 450 HP 6600 V 42 A
125 R.P.M.
℄ 12" ROUGHING MILL
MAX SECTION TAKEN BY ROUGHING ROLLS 3x3"
℄ OF 10" MILL
MAX SECTION TAKEN BY ROUGHING ROLLS
G.E. CO. IND. MOTOR TYPE I
CLASS 10/14-575-300/214
FORM M 25 CYC. 575 H.P.
6600 V 46/48 A 300-214 R.P.M.
℄ OF 16 ROUGHING MILL
MAX SECTION TAKEN BY ROUGHING ROLLS 5½x5½
G.E. CO. IND. MOTOR TYPE I
CLASS 30-800-100 FORM M
25 CYC. 800 HP 6600 V 77 A
100 R.P.M.
℄ OF 8 FINISHING MILL
G.E. CO. IND. MOTOR TYPE I
℄ OF 12 FINISHING MILL
G.E. CO. IND. MOTOR TYPE I
6600 V 64/68 A 214/167 R.P.M.

Fig. 3.

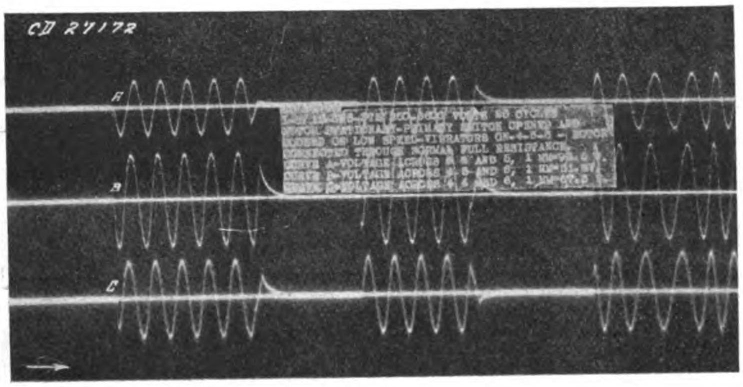

Fig. 4.

Figure 1 shows high peaks in the rotor voltage when the primary circuit is opened and closed and Figure 4 shows that no such voltage exists when the control is arranged so that the secondary is closed before the primary, and where the primary is opened before the secondary. This was accomplished by closing the first

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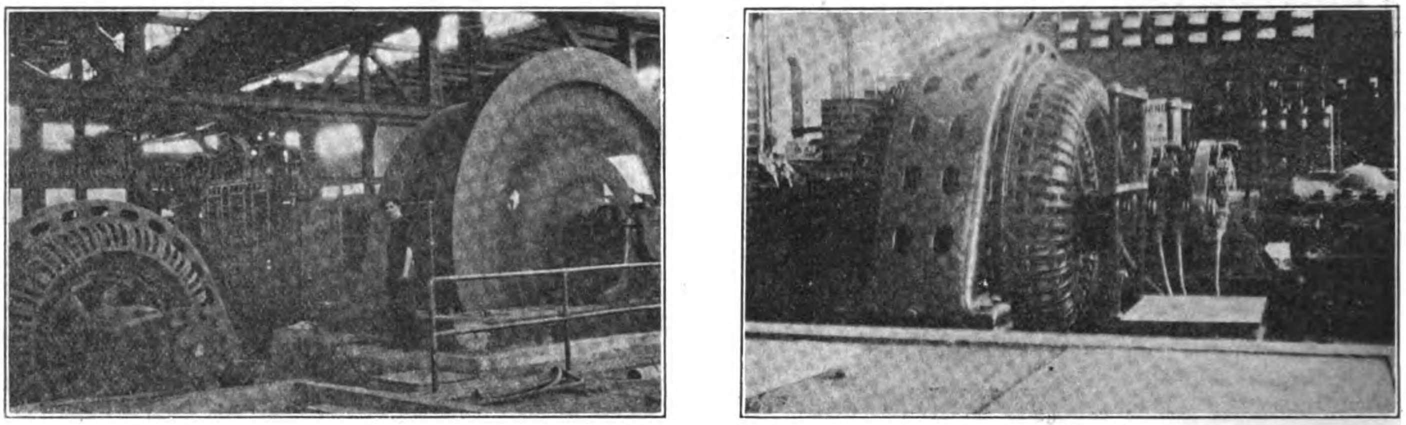
Paper presented before the Twelfth Annual Convention of the A. I. S. E. E.



Views of installation Type I, Form M, General Electric Induction Motors.

contactor on the secondary panel actuated by the speed switch before closing the direction switch on the two-speed motors. The single-speed motors giving no trouble because of the secondary always being closed.

It was also found necessary to mount two contactors on all double-speed motors to short-circuit the idle winding because high voltages in the idle winding were found to exist when starting or stopping.

Fig. 2 shows our lay-out for special steels of a crucible nature and as the starting of these mills has taken place only a few months ago, I will not attempt to show any tonnages or practices.

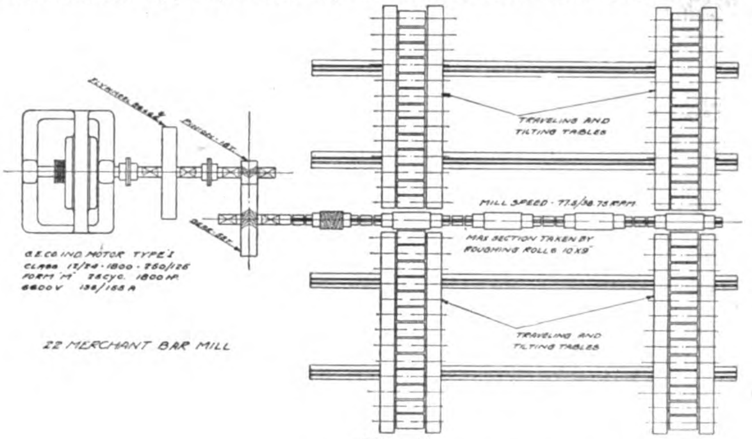

FLYWHEEL 86466 #
PINION 18T.
GEAR 82T.
G.E.CO.IND.MOTOR TYPE I
CLASS 12/24 · 1800 · 250/125
FORM "M" 25CYC. 1800 HP.
6600V 138/155 A
22 MERCHANT BAR MILL
TRAVELING AND TILTING TABLES
MILL SPEED · 77.5/38.75 RPM
MAX SECTION TAKEN BY ROUGHING ROLLS 10X9"
TRAVELING AND TILTING TABLES

Fig. 5.

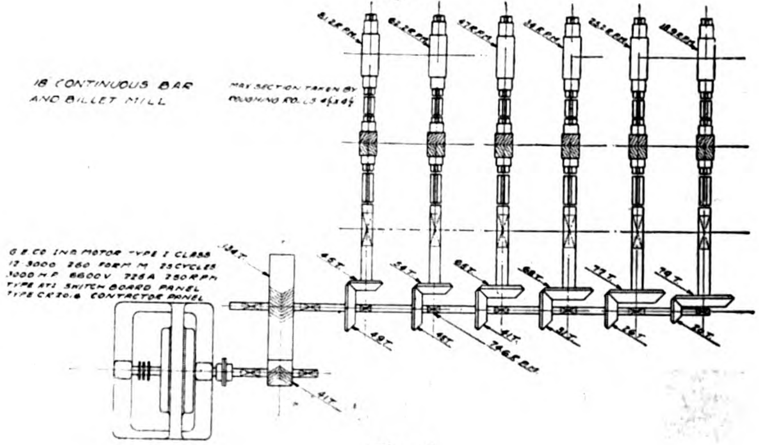

18 CONTINUOUS BAR AND BILLET MILL
MAX SECTION TAKEN BY ROUGHING ROLLS 4½x4½
G.E.CO. IND. MOTOR TYPE I CLASS 12-3000 250 FORM M 25CYCLES 3000 H.P. 6600V 225A 250RPM
TYPE AT1 SWITCH BOARD PANEL
TYPE CR 30.6 CONTACTOR PANEL
134T.
45T.
54T.
68T.
68T.
77T.
79T.
49T.
45T.
41T.
31T.
26T.
20T.
41T.
74.6 R.P.M.
47RPM.

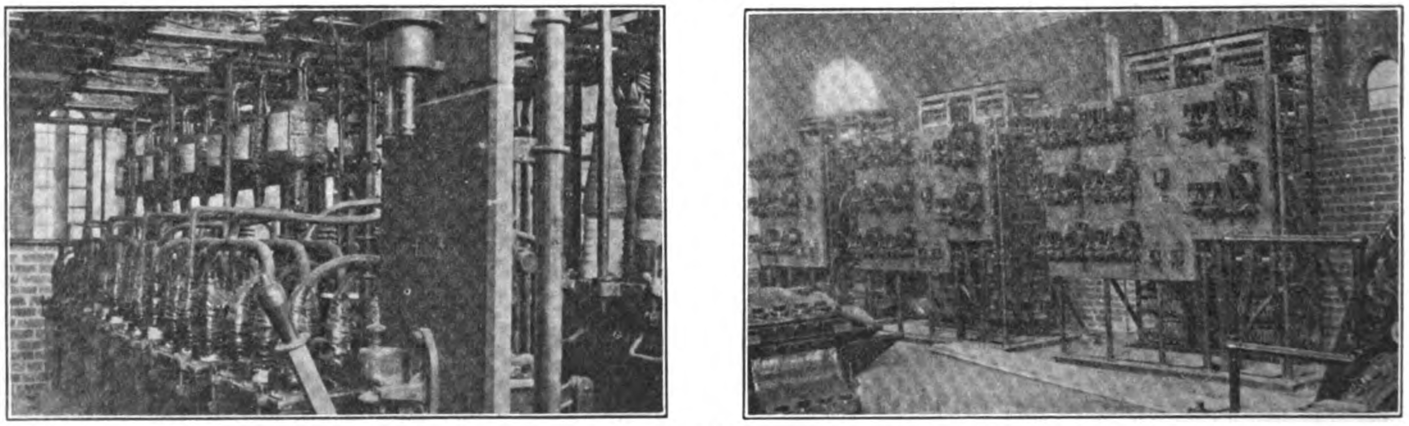
Fig. 6.

Figure 5 shows the 22-inch bar mill where maximum section bloom is 10 by 9 inches. The record monthly tonnage is 15,570.02 tons at the rate of 22.91 kw.-hours per ton. And on the mill is demonstrated the value of a balanced fly wheel (weight 86,466 pounds) which takes the high power peaks on breaking down.

Figure 6 shows the layout of the 18-inch Morgan continuous mill driven by a 3,000 horsepower General Electric induction motor, started January, 1916.

This mill up to the present time has not been run to capacity, due to a shortage of steel, but the average rate in kw-hours per ton is 28.5.

A word at this time



Control Installations.

in regard to operation. We find that motor houses over equipment of this kind lend quite a hand in upkeep of the drive motors, and in cases where it is possible to bring in fresh air from outside through a washing apparatus, a higher atmospheric pressure will be found in the room which keeps most of the mill dirt outside and so lessens the oxide covering which must collect in the cracks and crevices around the winding.

The motors in each of the groups are operated by one man who has an elevator type annunciator at his station, this and a system of rings makes it possible for almost any combination of operations to take place without commotion and makes it unnecessary for any other than the operator to be in the room.

The question of flywheels in connection with motor drives is one on which engineers differ, nevertheless experience has taught us that new installations should have a little more consideration in that respect.

For instance our 16-inch roughing mill has an 800 horsepower motor running at 100 rpm, the WR^2 of the rotor is 210,000 foot-pounds to this was added 2,500,000 foot-pounds by the use of flywheel, making a total of 2,710,000 foot-pounds. Now work performed and service required has shown us that on this layout a smaller motor would have done the work with some to spare and I feel safe in saying that our 12-inch bar mill equipment would have been more practical with a 500 horsepower motor (whose flywheel WR^2 value would be about 2,700,000 foot-pounds) on the rougher and a 12-inch finishing mill motor of 1,000 horsepower at 214 to 167 rpm with about 215,000 foot-pounds in the rotor.

The reason I mention an increase of 200 horsepower in the finishing mill drive and advocate plenty of power in all finishing mills is because of the heavy tonnages on flats and squares, which are possible if the roll stands are kept fairly full and we all know the satisfaction of being sure the motor will pull.

Fuel Economy in Blast Furnace Practice

Continuation of Discussion Concerning Results Obtained With Working Furnace Model Built for Determination of Efficient Distribution of Charge—Economy of Coke Consumption Effected.

By T. C. HUTCHINSON.

As new bells of the greater diameter could not be at once obtained, temporary expedient was resorted to. To increase the size of the old bells, wrought iron plates were riveted on to the rim of the 13-foot bell in No. 1 furnace so as to increase the diameter to 15 feet. (See Fig. 1.)

In September, 1884, a new bell, 15 feet 6 inches in diameter, was fixed in No. 1 furnace, and in May, 1886, a similar bell was fixed into No. 2 furnace. These bells were made in halves so as to pass one-half at a time through the hopper for bolting together previous to riveting. (See Fig. 2.)

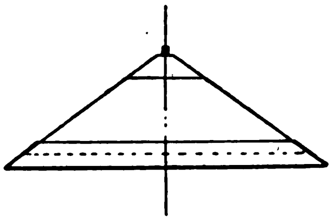


Fig. 1—Temporary method of increasing size of bell.

Owing to the fixing of these larger bells and the better distribution of material in the furnace the make of pig iron for each furnace was increased from 23,135 tons in 1881 to 27,949 tons in 1883 and 30,936 tons in 1884, an increase of 20.7 per cent with larger bell in one furnace, and an increase of 33.7 per cent, first year, with larger bell in both furnaces. This increased make of pig iron was not due in any way to mechanical cleaning of ironstone, as no cleaning belt was existent at Skinningrove until several years afterwards. The ironstone smelted in 1881 to 1886 was from the same mine; limestone from the same quarry; the coke used being Pease's West quality.

During the same period the blast was heated by cast iron stoves, maintaining a uniform heat from 900 to 1,000 deg. F. These cast iron stoves were afterwards replaced by firebrick stoves of the Cowper type, so that the coke economy as between 1881 and 1886 was not due to any improvement in heating of the blast. The consumption of coke per ton of iron for 1881 during the period of the 13-foot bell was 23.94 cwts. From 1884 to 1886 it was exactly 22 cwts., a saving of 2 cwts. per ton of pig iron.

Considerable further economy of coke consumption resulted from the substitution of Cowper stoves replacing the old cast iron ones, and for several years the coke consumption was maintained between 20 and 21 cwts. A low consumption of coke continued despite the gradual deterioration of Cleveland ironstone, which in 1886 averaged 27.94 per cent of metallic iron, as against 26.17 per cent in 1917, when larger quantities of limestone were required—15.73 cwts. per ton of iron as against 11.39 cwts. of limestone in 1886.

A comparative analysis of the slags in 1901 and

Conclusion of paper read before British Iron & Steel Institute.

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1917 confirms the extra limestone required to obtain a good working slag.

Average Analysis of Slags for 1901, 1902, 1903.

	Per cent
Silica	31.94
Alumina	23.95
Ferrous oxide	0.13
Manganous Oxide	0.93
Calcium oxide	33.01
Magnesium oxide	8.50
Ratio $\frac{CaO}{SiO_2}$	1.03

Average Analysis of Slags for 1915, 1916, 1917.

	Per cent
Silica	32.15
Alumina	24.44
Ferrous oxide	0.26
Manganous oxide	0.93
Calcium oxide	32.52
Magnesium oxide	8.20
Ratio $\frac{CaO}{SiO_2}$	1.01

It is not difficult to determine the cause of the increased make of 33.7 per cent of iron and the reduction of coke consumption of 2 cwts. per ton.

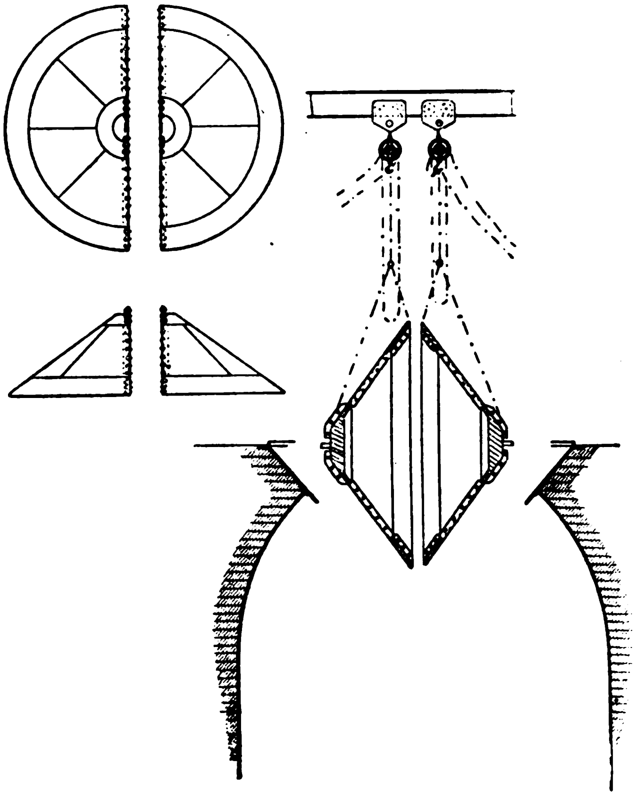

Fig. 2—Method of placing bell on furnace.

Owing to the better distribution of material in the furnace by use of bells of 15 feet 6 inches diameter, instead of those of 13 feet, there was the entire disappearance of the two distinct cones whose apexes permitted large material to fall towards the furnace wall, and also into the center of the furnace. For these two cones there was substituted one inverted cone whose diameter corresponded with the diameter of the larger bell, which threw the small mine and coke against the furnace walls, and this small followed the lines of the walls of the furnace as the burden descended to the tuyeres; also by directing the gases into one central channel instead of two separate channels, as shown in the model when using the small bell.

The saving of 2 cwts. of coke per ton of pig iron is due entirely to the better distribution in the furnace by the increased size of the bell.

The long life of the furnace lining is undoubtedly due to the protection of the brick lining by the small coke and mine thrown against the walls of the furnace, giving less radiation through the furnace walls, the small burden acting as a thermos.

The immediate cause of blowing out No. 1 furnace in December, 1900, and No. 2 furnace in April, 1903, was the rupture of the furnace casings, which permitted the gases to percolate through to the firebrick lining and to fire on the outside of the shell. Both furnaces at the time they were compelled to be blown out for that reason, were working on as low coke yield and making as much iron as Nos. 3 and 4.

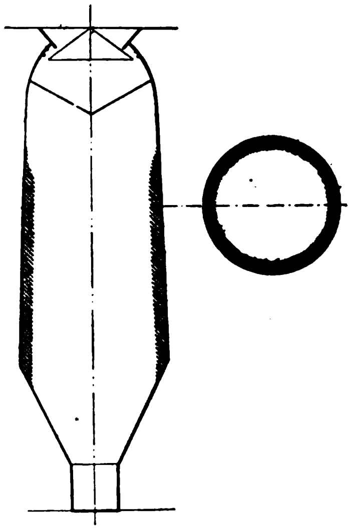

Fig. 3—Carbonaceous material formed on side of furnace lining by action of larger bell.

Had the furnace casing of Nos. 1 and 2 remained intact the lining would have had a longer life. When the old material was cleaned out from the well of No. 1 furnace, it was found that the dead small thrown by the larger bell against the walls of the furnace had been formed into a solid ring of carbonaceous material (Fig. 3) of the following analysis:

Carbonaceous Lining from Blast Furnace.

	Per cent
Metallic iron and magnetide oxide	17.00
Silica	10.54
Ferric Oxide	14.43
Alumina	7.88
Calcium oxide	7.65
Magnesium oxide	1.74
Carbonaceous matter	39.26
Alkalies	1.49

This ring extended for a considerable distance below the level to which the furnace was filled when blowing.

Operating Rules for Electric Cranes

Specific Rules Suggested by the Safety Committee of the American Iron and Steel Electrical Engineers for the Safe Operation of Cranes Actuated Entirely by Electric Current.

In accordance with a suggestion made by the board of directors, the Safety Committee of the A. I. S. E. E. has constructed, and herewith presents a code of rules for safe operation of electric cranes. While some of these rules might not be applicable to cranes that are actuated in part only by electric current, we have only intended to supply such as will apply to cranes actuated entirely by electric current. They have been constructed from data obtained from all available sources, and the effort has been to comply with any reasonable demands for safety without interference with efficient operation.

We would call the attention of those persons who object to making much effort toward publishing and distributing among employes, rules that should be complied with for prevention of accidents, on the grounds that employes will not take the trouble to read them or on any other grounds, to some pertinent facts that they seem to be overlooking. The law implies, and in some cases demands, that the hazards of every situation employes are brought in contact with, shall be made known to them before they begin their work; also that they be instructed how to do their work so that no injury may befall themselves or their fellow workmen. Does everybody realize that verbal instructions which may have been given, may not have been delivered in language so comprehensive they could not be mistaken, or that the weight of such verbal instructions may have been so slight memory could not retain them? That they might be denied and the doubt created would be favorable to a contestant? Supplying rules is a safeguarding requirement, and too, moral obligation requires that it be shown proper effort has been made to acquaint employes with them.

The payment of damage claims for personal injuries wrongfully inflicted, is an undeniable obligation and probably a just one; at least it is so decided in a majority of states, and no good business men are disposed to shirk this responsibility, but, as the laws are framed, unless employers make strict compliance with safeguarding requirements, claimants can refuse to accept the compensation prescribed by law, and call on the courts to make satisfactory adjustment. Regardless of how much their own negligence may have contributed toward their own injury, usually they are awarded the full amount that will cover the damage sustained and proven. This too may be right, and in order to avoid the prescribing of too much safeguarding by law makers, that would be burdensome to employers, and would tend to make employes unconcerned about avoidance of accidents; also, in order to guard against imposition, the law should be so fully complied with that there would be no just grounds for refusing to accept the compensation provided.

The requirement that employes should be instructed as to the hazard of their work and how to perfom it safely, is a reasonable one, and it cannot be complied with more effectively than by supplying each employe with a printed copy of such instructions. This need not abrogate the requirement for those in authority to give verbal instructions, but it should preclude the possibility of denying that full instructions had been given. Carefully printed instructions are less likely to be incomplete than are those that are verbally delivered. An ignorance of the law is no justification for violation of it, so it might be claimed ignorance of safety rules that have been printed and placed in the hand, is no justification for violation of them.

A set of rules for safe operation of cranes cannot be fully effective unless they provide for their own enforcement, therefore, each rule or paragraph, of the code we have submitted, states the duty and authority of each employe where matters pertaining to safety are concerned. We have submitted no rules but that should be carried out, where they will apply, even at the cost of delays, and there are none but that should have a helpful bearing on efficiency in getting out product. They are intended to be a guide to those who may be in need of suggestions concerning safe methods for operation of cranes and the effort has been to include the whole gospel. As it remains for the persons who may make use of them to say how imperative their expression shall be, the word should has been used instead of some other auxiliary verb in all cases where a command might be expressed. The complete code as agreed on by the committee is as follows:

Rules for Safe Operation of Electric Cranes.

1—While the operators of cranes usually are subject to orders of operating foremen, in the departments where they are employed, they should not start a motor even when ordered to do so, if so doing is likely to cause an accident.

a—A signal to stop the travel of a crane or the movement of any of its parts, by whoever given, should be obeyed.

b—A motor should not be started, to make a lift, if the operator knows that an improper hitch has been made with chains or slings, or if hooks permanently attached to the crane fixtures are not properly adjusted.

c—In any case of doubt as to making a lift with safety, the crane operator should call the attention of the

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Paper read before Twelfth annual convention of the A. I. S. E. E.

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foreman in charge to the condition that created the doubt.

2—The crane operator should be held responsible for the safe condition of his crane insomuch as he should know by observation from his cab, and from inspections of the entire crane.

a—He should see that all bearings are properly oiled; that all cables are traveling properly on their drums; that brakes, limit devices, controllers, switches, hooks, yokes, blocks and other attachments, are in good and proper condition.

3—Operation of cranes, while doing construction or repair work, should be governed by a code of signals prescribed by the management. They should be given by some one designated person known by the operator to have authority. On occasions when it obviously is necessary to deviate from this rule, the operator should act with exceeding caution.

a—Cranes engaged in their regular routine work, should follow such practices as is the custom in the mills they are operated in and as has been agreed on by the operating management.

b—Changing rolls, removing and replacing parts of machinery, working two cranes to lift one load, and all unusual operations are classified with repair work, and operators should be governed by signals when cranes are so employed.

4—When more than one crane is operating on a runway, an audible signal should be sounded to avoid collisions when moving. Signals should be sounded when cranes are moving while carrying suspended loads in the vicinity of where men are working.

5—Cranes carrying material should be so manipulated as to avoid carrying suspended loads, or magnets with or without loads, over men working below. In case where men working below cannot or do not, from any cause whatever, move away, the crane should stop if the line of travel of the load or magnet is over the workmen.

6—Operators on leaving their crane cabs to inspect, oil or repair parts, or to get off the crane, should open the main switch and lock it open with a safety seal lock.

a—Switches controlling the current to magnets should be kept constantly open and locked open while the magnets are detached, or while they are not in use.

b—On notification from workmen that they want to disconnect the magnet, the operator should open the main switch and lock it open, before the wires are disconnected.

7—When handling ladles filled with molten metal, the brakes for controlling ladle hoists should be tried to see if they are in good working order before the ladle is moved from over its support. To make this trial the ladle should be lifted a slight distance then apply the brake to see if it will hold the load.

a—Ladle cranes with but single motors and outfits for the ladle hoist should not be used to handle a ladle containing metal when the brakes will not hold.

8—Operators should not leave the crane cab for any purpose whatever while a heat of metal is suspended from the crane. In case any adjustment of parts of the crane is required help should be called on to make it.

9—Operators should be responsible for preventing men from riding on their cranes who are not required to do so for some purpose. They also should be responsible for preventing men from riding on any attachment to the cranes as hooks, magnets, etc.

a—At all times, whether carrying loads or not, hooks and chains should be kept high enough to clear men or apparatus below the crane.

b—Blocks should not be lowered below a point where less than 1½ turns of cable will remain on the drum.

10—It is not good practice to make side pulls. If they are permitted they never should be made by use of ladle hoist.

11—Prompt action is required to stop the descent of a load when the brake will not hold. If it should be necessary to apply power to a motor in order to stop the travel of a crane or the descent of a load, the contact point of the controller lever should be moved, for lifting or reversing as the case may require, one point only beyond the off position. If this does not give enough power then try the second point, containing the movement one point at a time as necessity requires, but no more power should be applied than is actually required to bring the crane or load to a stop.

12—Two or more safety seal locks, for locking switches open, should be carried in crane cabs along with the tool equipment. These locks should not be used for any other purpose than to keep a circuit open when the closing of it might cause an accident.

a—The crane operator should use a safety lock for locking the main switch open every time he leaves the cab to go on the crane runway, or out on the crane for inspection or to make adjustment of parts.

b—The inspector should, in addition to notifying the crane operator of his intentions, use a safety lock for locking the main switch open, every time he goes out on the crane.

c—Repairmen should, in addition to notifying the crane operator of their intentions, use a safety lock for locking the main switch open, every time they go on the crane. The foreman in charge of repairs, should be responsible for locking open the main switch and all individual switches, while repairs are going on, and for removing the locks when the repairs are finished and the men are off the crane.

d—After all safety locks have been removed from the main switch, the crane operator should assure himself that nobody is in danger from movement of crane, before he closes main switch.

13—A crane should be inspected by its operator when he takes charge of it at the beginning of his turn. The regular crane inspector should make inspection as soon as he can after beginning his daily work. Operators and inspectors should make inspection of the cranes at every convenient opportunity. Any defect that they may not be able to repair or correct, though it may not be serious enough to require stoppage of the crane, should be repeatedly reported until it has been cared for.

14—Ordinarily, when inspecting a crane, the main switch should be open and locked open with a safety lock. If in the course of inspection it should be necessary to see a motor running or see some part of the equipment with current on, the inspector should notify the crane operator to close main switch, after locking open all other switches than the switch controlling the circuit he desires should be closed. The inspector and operator should keep in close touch with each other's movements, and when the current is no longer needed for an individual circuit, the inspector should see that the operator again opens the main switch and locks it open.

15—Inspectors should be held responsible for the correct setting of circuit breakers and the proper size of fuses.

16—Inspectors and repairmen should see that no loose material is left on cranes, that might fall off.

17—Work is sometimes done on or near crane runways, by employes of the various mechanical departments, when it may be necessary for them to get on and off the runway at times. If notified that work is to be done on or near a crane runway, or on seeing evidence that employes are going to do any, the crane operator should take necessary steps to have the following regulations complied with: A reliable flagman should be detailed to ride in the cab of each crane that may be on the runway, whose duty should be to look after the safety of the workmen. The flagman should place track torpedoes on the runway rail that is nearest to the crane cab, at points not less than 75 feet, each way if necessary, from the place where men are working, using two torpedoes at each point, and should see that the crane is not taken into the protected zone unless he knows the workmen are out of danger. The operator on hearing a torpedo explode should immediately stop his crane.

a—In cases where a device is used for automatically opening the circuit and applying the brake to stop the bridge travel, all other methods for limiting the travel of the crane, except placing track torpedoes, may be dispensed with.

18—Under no circumstances should circuit breakers, limit devices, or other safety appliances, be locked or otherwise rendered inoperative.

19—Limit switches installed for safety, should not be brought into service intentionally, nor should they be depended upon to stop the travel of a hoist.

20—If power goes off, switches should be pulled out and controllers moved to the off position.

21—Under no circumstances should bridge and hoist, or trolley and hoist, be operated simultaneously unless the load is hanging.

22—Before starting to remove a hoist shaft, change a hoist brake or crane armature, where practicable, the ropes or chains should be run entirely off the drum; always when performing any of these operations, the gearing should be carefully locked to prevent the drum turning.

Bulletin for Placing in Crane Cabs.

Notice to Crane Operators.

1—None but regularly authorized persons are allowed to use this crane.

2—Thoroughly inspect all parts of your crane at the beginning of each turn.

3—Do not operate your crane when it is not in a safe condition; report defects at once.

4—Do not operate your crane when anybody is working on any part of it, unless authorized by repair foreman to do so.

5—Move only on signal from the proper person; be sure the trolley is directly over the load to be lifted; be sure everybody is clear; ring gong; start slowly.

6—You will not be excused for carrying loads over men. Watch your chain hooks.

7—Do not allow anybody to ride on magnet, load or hooks.

8—Do not allow loose material or tools to remain on trolley, footwalks or runways.

9—Do not leave the cab without first opening the main switch and placing safety lock on same.

10—Do not allow repairs to be made on bridge or trolley unless repairmen place a safety lock on open main switch and on each individual motor switch.

11—Refuse to lift cinder cakes or any other load that you know cannot be handled safely, unless foreman insists that you do so.

Overhead Traveling Crane Bridge Motors

Tests of Rolling Friction and Rate of Acceleration on Several Manually-Controlled Crane Bridges — Graph Showing Convenient Method of Checking Motor Size and Gear Ratio.

By R. H. McLAIN.

The purpose of this article is to set forth some rules for selecting the proper size of motor and gear ratio for bridge motion of overhead traveling cranes. Undoubtedly a great deal of data has been accumulated on this subject, and is on record in various engineering organizations. I have seen nothing published on this subject which would enable past experience to be applied to new projects where some of the conditions are changed. I hope that this short and incomplete articl may start an accumulation of data in a uniform manner which will eventually lead to a complete solutio of this problem. I am taking up the bridge motor now because of the cases of trouble due to incorrect motoring and gearing which have come to my attention. Thi motor seems to give the most trouble.

The work done by the bridge motor consists o three parts—first, overcoming track resistance and journal friction—sometimes, together, called rolling

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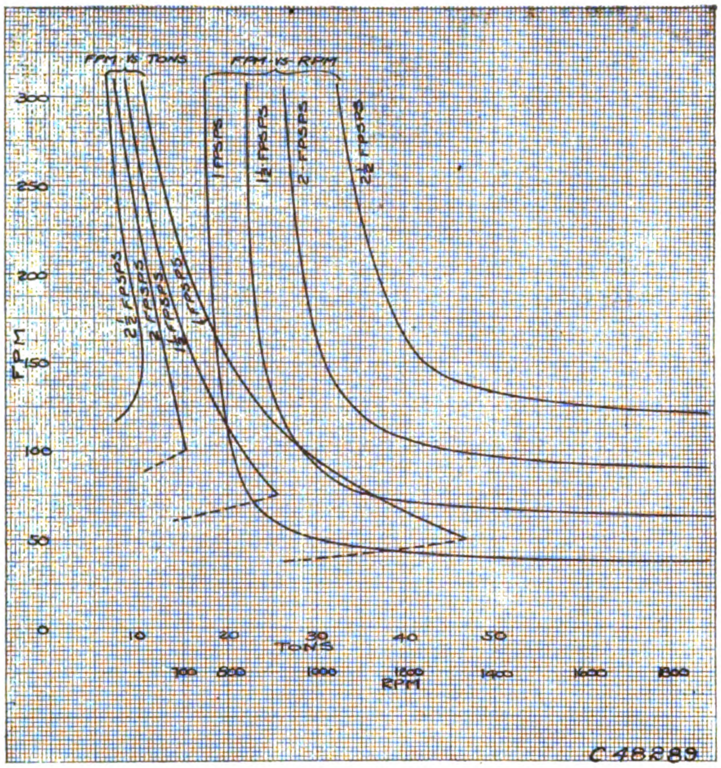

Fig. 1—Curve for determining work of motor.

friction; second, accelerating the crane with load; third, accelerating the motor armature and brake wheel. The first and second items of work above are done through a train of gears and involve gear losses. In the majority of busy cranes, the rolling friction is a small part of the total work and acceleration is the main work. Usually a draw-bar pull of from 20 to 30 pounds per ton will move a well made crane along a good level track. A new stiff crane or a poor track may require 56 to 60 pounds per ton. Acceleration of the crane and armature may require anywhere from 50 to 300 pounds per ton draw-bar pull, depending on circumstances. In order to determine the amount of work usually required for acceleration I have analyzed tests on 11 manually controlled cranes as tabulated below.

There are four things which tend to limit the rate of acceleration of a bridge motor:

1—Automatic magnetic control can absolutely limit it.
2—Slipping of wheels can practically limit it.
3—Swinging of load can limit it in some cases.
4—Comfort of operator may limit it.

When automatic magnetic control is used, the current-limit devices may be set to a value of current just sufficient to start the crane under the severest working conditions and if the current is within the working limits of the motor no trouble need be expected on the crane. Of course, trouble can arise if the controller fails to function properly or if the operator "speeds up" the crane by setting the relays for higher current. To safeguard against this last difficulty it is, of course, necessary to select a motor large enough to make all the speed actually needed. An average acceleration of something like 1 to 1½ ft. per sec. per sec. will be fast enough for cranes which travel at less than 500 ft. per min. or make infrequent starts. Cranes which make regular frequent trips of 50 or 60 ft. every min. or so may need an average acceleration of 2 to 2½ ft. per second per second. Cranes which do "stunts" with swinging loads like some bucket cranes, which swing a bucket into a hopper, or hot metal ladle cranes, may need even 3 feet per second per second peak acceleration.

When a motor is powerful enough to slip the wheels under full load without exceeding the working limits of the motor, it is out of danger. A simple calculation* shows that if one-fourth of the wheels are driven and if these wheels carry one-fourth of the total weight, an acceleration peak of 2 ft. per sec. per sec. will just about slip the wheels. Of course, the average acceleration will be less than the peak and will depend on the num-

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*Assume a coefficient of friction between the wheels and the rail of 25%. Then the available draw-bar pull from one-fourth of the wheels will be 25/4 or 6.25% of the weight of the crane. Gravity (or the total weight of the crane) will accelerate the crane at 32.2 ft. per second per second—therefore 6.25% will accelerate it at .0625 × 32.2 or 2 ft. per second per second. This calculation omits some niceties about rolling friction but they are relatively unimportant.

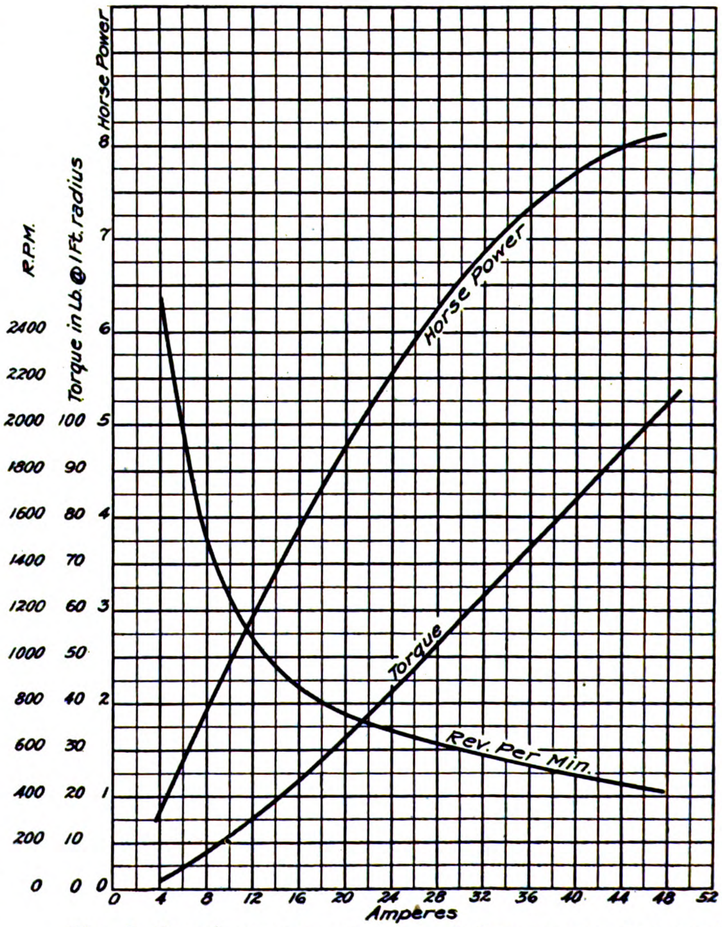

Fig. 2—Speed, torque, current and horsepower characteristics of motor.

ber of controller steps. Usually the average acceleration may be about 1.5 ft. per sec. per sec. If one-half the wheels are driven, the rates of acceleration may be double the values above. Of course, it is possible for a vicious operator to turn his controller on so rapidly, after the wheels slip, that the power required to spin the wheels and accelerate the armature will exceed the motor limits; but this is hardly to be expected. Where it is possible for a crane to do its work with only one-fourth of the wheels driven, this drive makes a very practical way of protecting the motor, but, where one-half of the wheels must be driven, the motor is not so protected from overload.

The swinging of the load will, in some cases, have a great deal to do with the rate of acceleration. Unfortunately, I have very little enlightening data on this part of the problem. Discussion of this by the members of the association would be valuable.

It is interesting to note that when the load is hung from the crane by a flexible rope, the motor does not have to start the load as soon as the crane starts. This relieves the motor somewhat. At the first instant of starting, the motor has to overcome rolling friction of total weight of crane and load, and it has to accelerate the crane and armature. As the crane moves away from the load, the load begins to accelerate at a rate far below that of the crane and finally when the crane has moved far enough away from the load, the load is accelerated as rapidly as the crane. This fact is mentioned here because it will be one point of interest in the table below.

Where manual control is used, rough material is being handled, and one-half of the wheels are driven, the discomfort of the operator is the only other thing which limits the strain which may be put on a motor due to the quick start. In order to get an idea of how quickly an operator will permit himself to be started, I have asked several members of the association to send me test data on their cranes. The results are given in table No. 1:

The calculations for this table were made as follows:

Let C = Weight of crane in pounds.
L = Weight of suspended load in pounds.
N = Revolutions of motor armature which corresponds to one foot travel of the bridge along the track.
W = The effective weight of the armature and brake wheel plus an allowance of 5% for gears expressed in pounds at one foot radius on the armature shaft, i. e. the flywheel effect.
P = Maximum torque in pounds at one foot radius exerted by the armature as determined by reading amperes for the one condition which is being tested, and referred to manufacturer's torque-ampere curve.
F = Torque as above exerted when motor is fully accelerated and is overcoming rolling friction only.

$$e = \frac{\text{Efficiency of gearing expressed in per cent.}}{100}$$

To find rate of acceleration on crane without load—

Rate of acceleration in feet per second per second

$$= 32.2 \frac{P-F}{\dfrac{C}{2\pi Ne} + 2\pi NW} \qquad\qquad (1)$$

To find rate of acceleration on crane with load rigidly attached to crane (or with load swung behind crane at such an angle that the two accelerate at the same speed)—

Rate of acceleration in feet per second per second

$$= 32.2 \frac{P-F}{\dfrac{C+L}{2\pi Ne} + 2\pi NW} \qquad\qquad (2)$$

To find first instantaneous rate of acceleration on crane bridge when load is swung by flexible rope or chain vertically below the bridge so that bridge starts to move before the load starts:

Substitute the values of P and F as used in equation No. 2 in equation No. 1 and obtain instantaneous rate of acceleration in feet per second per second.

Reference Number	1	2	3	4	5	6	7	8	9	10	11	12
Weight in pounds of complete crane	12000	46000	88000	50000	90000	84825	320000	203400	44000	100000	90000	84000
Rated load of crane in tons	10	10	35	10			100	50	10		35	
Actual load on crane hook in pounds	5000	8000	10000		11000	20000	250000	2000	500	68000	60000	24000
Rolling friction of empty cranse in pounds per ton	30.9	22.4	16.15	27.8	25.8	20.3	4.55	23.7	8.26	20	29.8	30.
Rolling friction of empty cranes in pounds per ton		27.2	12.75		25.8	23	4.68	23.5	8.6	24	30.1	25.3
Free running speed of bridge in feet per minute—empty	677		437	523	346	538	550	365	800	367	635	462
Free running speed of bridge in feet per minute—loaded	677		383		328	487	510		750	317	520	436
Peak rate of acceleration in feet per second per second—empty	2.92	1.205	1.09	.833	.54	1.606	3.09	1.635	.912	1.47	1.755	.84
Peak rate of acceleration in feet per second per second—loaded	2.13	.585	.745		.348	1.24	1.85	1.855	.997	1.9	1.235	.77
Nature of work	Gen'l	Yard	Gen'l		Stand by	Gen'l	Hot Met.	Gen'l	Gen'l	Hot Met.	Gen'l	Yard
Owner	G. E.	Am. Lo.	Am.Lo.	Am.Lo.	Tenn.Coal	Carn.	Beth.	Beth.	Beth.	Ill. Steel	Erie F'ge	Carn.
Maker	Box	Case	Niles	North'n	Morgan	H'mstd.	Alliance	P.&H.	Sh'p'd	Clevel'd	Toledo	Mor. Eng.
Pear rate of acceleration of bridge before suspended load starts	2.92	.694	1.285		.905	1.5	3.05	1.88	1.01	3	1.975	.98

Table No. 1

This rate is maintained only long enough for the bridge to move away from the load. Then the rate reduces gradually to equation (2).

The rate of acceleration is absolutely as important as the final speed of the crane in determining the size of motor for a crane. In order to show what a given motor may do under various loads, speed and rates of acceleration without drawing a peak above its working limit, I have prepared Fig. No. 1. Fig. No. 2 shows the speed, torque, current and horsepower characteristics of the motor. Fig. No. 1 is calculated on several assumptions which may not be altogether correct, but the curves make a very good basis for comparing conditions. These assumptions are that rolling friction of crane is 50 pounds per ton and that there are no gear losses between the motor and track. The maximum peak torque allowable at the motor shaft is taken as 78 lbs. ft. The total flywheel effect of motor armature brake wheel and gears is taken as 8.4 lbs. at one foot radius on armature shaft. Fig. 1 is suggested as a very convenient form of curves for determining the work a motor can do; but, of course, to cover conditions more completely it might be necessary to make up, for every motor, several sets of curves, e. g. one set for 20 lbs. per ton rolling friction, one for 35 lbs. per ton, etc. Fifty lbs. per ton rolling friction was chosen because, while this is too high for most cranes after they have worn smooth, it is often correct for new cranes. It is easy to apply a correction for gear losses to any of these curves, e. g. if the curve indicates that a motor can handle 10 tons in the desired manner, this may be cut to 9 or 9.5 tons so as to allow for gear losses. The way to use Figure 1 is as follows: Suppose a 12.5 ton loaded crane is being considered, and a rate of acceleration of 2 feet per second per second is desired, read up from 12.5 tons to the curve marked "2 feet per second per second." The intersection is at 170 f.p.m. Then read across from 170 f.p.m. to the f.p.m. vs r.p.m. curve marked "2 feet per second per second." The intersection is at 995 r.p.m. This indicates that the motor should be geared so that 995 r.p.m. corresponds to 170 f.p.m. and that, when so geared, it can start 12.5 tons at 2 feet per second per second peak acceleration without exceeding 78 lbs. ft. torque on the motor shaft.

Cranes are frequently used for dragging cars and, consequently, the bridge motors must be large enough to do extra work, when so used. This problem would be something like an electric locomotive problem and this paper will not discuss it. I believe that the rates of acceleration may be somewhere near those shown in table above.

The only elements of uncertainty about applying Figure 1 in determining whether a given motor will handle a given crane is the rolling or track friction, and the rate of acceleration needed. From a study of the table I would say that if 50 pounds per ton is used for track friction, and 3 ft. per sec. per sec. as the peak rate for accelerating the crane (without load), the motor will be large enough for all cases and too large for most cases.

In order to crystallize the contents of this paper, I would suggest the following as rules for the selection of motors and gearing for bridge motion:

1—If a large number of cranes are to be considered, prepare a curve similar to Figure 1, which will show the limitations of a motor. If only one crane is to be considered, make a guess at the proper size of motor and gearing and then check it up by the equations (1), (2) and (3) given in the preceding part of this article.

2—If automatic magnetic control is going to be used on the crane, plan for a peak acceleration of 2 ft. per sec. per sec. for all cranes except those which do "stunts" by swinging the load or which make very short, rapid trips of something like 50 or 60 ft. per minute. In this case, plan on a peak acceleration of 3 ft. per second per second.

3—If only one-fourth of the wheels are driven it is not, in any event, necessary to plan for a greater peak acceleration than 2 ft. per second per second.

4—If the crane is to be manually controlled, plan on a peak acceleration of anywhere from 1 to 3 ft. per second per second depending on the nature of the work. For power house and stand-by cranes, 1 foot per second per second is ample; for hot metal ladle cranes 3 ft. per second per second; and for busy loading cranes 2 to 3 feet per second per second.

5—In deciding what peak of acceleration the motor can stand without damage to itself, the particular characteristics of the motor should be determined by referring to the manufacturer, but in any event there should be no sparking at the commutator when the motor is started at the maximum rate and the shaft and bearing stresses should come within conservative limits at these rates.

I hope that more data can be accumulated as to the rate at which operators are inclined to start various classes of cranes and that from this data a more definite rule similar to fourth above may be decided on.

EDITOR'S NOTE—Mr. McLain's paper caused a great deal of interest at the convention. Few papers were discussed with as much interest and enthusiasm, and there is no doubt that a great deal of interesting and valuable data has been added to the general fund of knowledge on this subject. The tables and curves will be found of value and it is to be hoped that more of this sort of data will be available in the future. The suggestion offered in the discussion concerning the placing of motors is worthy of consideration. It being suggested if the bridge of a crane is of sufficient weight to require two motors, that the most satisfactory method of drive would be to place one motor on each side of the bridge in the center of the span, applying the method to all four traction wheels.

Educating Steel Mill Electrical Employes

Education Proposed Solution for Labor Problem Relative to Electrical Employes in the Iron and Steel Industry—A. I. S. E. E. Committee Suggests Plan of Action and Courses of Study.

Due to the great number of men who have enlisted and are now fighting for our flag, and due to the difficulty of obtaining efficient and trained men in the electrical departments of iron and steel mills, the educational committee of the Association of Iron and Steel Electrical Engineers has for the past five months directed its efforts to discover the extent to which the electrical employees in the various steel industries are being trained by special educational methods for their chosen trades. We fully realize that the main problem today is the "MAN" problem, on the solution of which, hinges largely the success or failure of our industrial enterprises. Furthermore we feel that the cost of labor turnover could be greatly reduced by our respective companies adopting a systematic industrial training course, and in this way aiding their men to prepare themselves along the lines of their chosen trades.

The question of educational method for application to electrical employees is of such importance, and as there are so many varying opinions as to the adaptability of certain methods to specific subjects, that our committee feels it advisable to proced with caution, and present to the association only such suggestions as have proven to be of practical application and value to our purpose.

In order to arrive at a definite educational method to put before this association, the educational committee wrote to a number of the various plant superintendents asking each to submit complete and full information pertaining to the following as related to his particular plant:

1—An outline as to what work is being done along educational lines for electrical department employes.
2—Suggestions in regard to this work.

The various schemes and suggestions offered have been tabulated in this report and the suggested method of education proposed by the committee has been made up by selecting the best points contained in each scheme and combining them so as to formulate a definite and well rounded course adaptable to the educational needs of the electrical employees of any plant and it is our earnest recommendation that this suggested course, or suggested course, with revisions, be acted upon favorably by this association.

The term method as used comprehends everything that pertains to the system in the presentation of subjects of instruction to students. General method considers only the fundamental principles upon which instruction should be based; special methods develop the application of these principles to the several subjects constituting the outline of study. The fundamental principles upon which our electrical course is based must be thoroughly understood by each student and also by the instructor, so that the processes of acquisition of new material for knowledge may be facilitated. It is within recent time that method has been scientifically worked out and become entitled to respect as a matter of serious study. There are many definitions of method, but the one best suited to cover our electrical endeavors is "A complete set or system of rules for procedure, which teaches how to arrange thoughts for investigation or exposition."

It is our opinion that the best way of testing the value of any educational method is to determine the kind of results it has produced upon the classes as a whole and also individually. Also find out the following:

a—Has the student's mind developed the power of sustained concentration?

b—Has he developed the ability to make logical judgments respecting important problems?

c—Is the student's work acurate in every detail?

Any method or system that produces results of this kind has shown its right of adoption and of receiving undivided support. Furthermore, does the success of such results depend upon the student or upon the teacher? In classes such as we will have in the electrical departments of our steel mills, we will surely find those who are ambitious and desirous of acquiring knowledge and also those whose ambitions at first appear well-founded, but they soon lose interest as the novelty of the subjects taught disappears. We feel that the success of our educational course in electrical work will depend entirely upon the teacher. It is he who must impart knowledge and also create an atmosphere of interest which must be sustained throughout. The instructors for the electrical employe students should be first-class, all-around men, who have had many years of experience and have reached the age where their judgment is of such a nature, that they will not jump to conclusions and will have infinite patience; for we know that mistakes will be many. In correcting a student, judgment and patience should always be used and the instructor should be one who has a great liking for young men and is interested in their welfare, broad enough to overlook their failings and when correction is required he should be of such

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Paper presented before the Twelfth Annual Convention of the A. I. S. E. E.

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a disposition that he can make the student realize the importance of doing his work well and correctly, without leaving a sore spot.

Furthermore the success of our electrical course will also depend to a considerable extent upon the subjects taught. These subjects must be either intimately related to the electrical work carried on in the mill or they must be subjects definitely requested by the students themselves. Nothing will prove more detrimental to the student than the interjection of subjects not directly applicable to the work of our electrical departments and for which he has no particular inclination. There are 10 rules for the teaching of young men that have been evolved from the personal experience of the members of this committee, and we feel that they should be followed by the plants conducting classes of this kind:

1—Teach the student only one thing at a time.
2—Present the subjects as systematically as possible.
3 Make the student understand the connection between successive parts of the subject.
4—Use words that express your meaning in as simple a manner as possible.
5—Whenever possible make illustrations and demonstrations in such form that they can be easily seen and understood.
6—Teach the student to analyze his problem.
7—Make the student write out all parts of his data and solutions systematically and plainly.
8—Drill him in various problems involving the different principles, without making the work monotonous.
9—Do not give him a job that you know is too hard for him.
10—Above all do not assist him to much, but draw him out and develop his reasoning powers by means of various questions.

In considering the replies submitted by the various companies, the subjects taught in the different plants have been grouped under nine headings:

1—Electricity and magnetism.
2—Physics.
3—Electrical calculations.
4—Elementary school subjects.
5—Transformers, motors, generators, etc.
6—Testing.
7—Sketching and mechanical drawing.
8—Diagramming.
9—Manufacturing processes.

To understand better as to how the committee has approached the question as to methods of instruction for electrical students, a statement is given below with a brief description of each.

1—Laboratory Method.

This method in the broad meaning of the word signifies learning by doing things. From all the replies received this method appears to be the most popular and we feel is most valuable in bringing out any ideas the student may have. In other words it tests his originality. The committee strongly feels that an electrical laboratory used in connection with the class room work of the electrical department's students would be an ideal and profitable institution.

2—The Study and Recitation Method.

This is a very necessary method needed in carrying on the teaching of the theoretical work in connection with the laboratory work.

3—The Lecture Method.

This method with examinations involves lectures wherein the students are required to take notes and are later given a thorough test on the lectured subject. This method has not proven very satisfactory and is not recommended except that a lecture occasionally on some up-to-date live subject may aid materially in keeping up the student's interest in his classroom work.

4—The Inspection Trip Method.

In general by this method the class should be divided into two or three parts and conducted through the mills by the instructors, who should be thoroughly familiar with the electrical equipment and the mill operations, and capable of answering promptly any questions the students may ask. The next class meeting following the inspection trip is usually devoted to discussion and instruction concerning the information gained in the trip through the mill. These inspection trips also aid greatly in keeping up the student's interest.

5—The Conference Method.

This method entails group discussion and debate of the assigned topic. Students are required to take notes on the points brought out in the meeting and are later examined on these points. This method we believe is more adapted to carrying on educational work among a higher class of employees than we have in our electrical school. It is not advisable to assemble an educated lot of employees for conference until their minds have become sufficiently developed to get an insight into any conversation that is being carried on in their presence.

6—Local Instruction School Method.

The Y. M. C. A. and the correspondence schools in every mill town have courses planned to cover the various phases of steel mill and industrial electrical work in as thorough and comprehensive a way as may be done in the short time of one season. The course usually covers the work in a hurried manner. The method is to select a number of electrical men from the department employes and sending them to this school, but some one in the department must be designated to look after their progress and report to the department once a month.

A summary of the subjects taught under the methods listed above is given herewith:

A—Method No. 1.

a—High school subjects.
b—Meter and motor testing.

c—Automatic controllers.
d—Drum controllers.
e—Mechanical and electrical braking.
f—Open and concealed wiring.
g—Shop mathematics.

B—Method No. 2.
a—Elementary school subjects.
b—Sketching and drawing.
c—Transformers, motors and generators.
d—Laws of electricity.

C—Method No. 3.
a—Vocational and educational subjects.
b—Manufacturing processes.
c—Apparatus equipment and the uses of same.

D—Method No. 4.
a—Manufacturing processes.
b—Observation powers.

E—Method No. 5.
a—Assigned topics.

F—Method No. 6.
a—Elements of electricity.
b—Transmission.
c—Magnetism.
d—Generators and motors.
e—Controllers and switchboards.
f—Transformers and miscellaneous applications of electricity.

The committee feels that the best results can be obtained for both the men and the company by each plant operating its own electrical school. However, where this is impossible, as in the case of Plant No. 6, recourse can be had to the local Y. M. C. A. school of instruction or something similar. This plant No. 6 states that they have had excellent success from this method, about 33 men taking advantage of the electrical course during the past year. They kept track of their men by having a complete report of the progress of each man in the electrical class submitted each month to the department superintendent and through him to each man's foreman. By this method the foreman can brace up those men whose attendance at classes has been irregular and whose work is not satisfactory.

In considering therefore the various data and information submitted by the different companies, the committee would suggest that the course that has been arrived at after careful consideration be discussed fully by the members and some steps be taken for its adoption in the electrical departments of all steel plants. We would respectfully propose the following outline of course of instruction:

A—Initial Conditions.

1—Classroom and equipment.—We recommend that classrooms be located as centrally and conveniently as possible within the confines of the plant and preferably in the electrical office building. They should be clean, properly lighted and well ventilated and expense should not be spared in the equipment. Industrial men have all come to a realization of the true economy of up-to-date equipment; and just as out-of-date machinery is ruthlessly scrapped in the shops, so must the electrical school instructor be content with nothing less than adequate and modern equipment in his class rooms. Manifestly, the details of the equipment of each school room is a matter which must conform to the needs of each individual school, but we do state that adequate equipment systematically arranged is a sure preventative of delay and lost motion in any kind of classroom work. The laboratory, which will be used in conjunction with the classroom, should be neatly arranged. The wiring up of motors, generators, control boards, etc., in this room should be ideal in every respect, for the student should be instructed to make his work in the mill as neat appearing and as substantial as the examples he sees in the laboratory. The full equipment for various kinds of tests should be installed. It would be well to have a hoist motor mounted on beams above with the control on the floor typical of crane operation. This hoist motor should be equipped with dynamic and solenoid braking and should have the hoist limit installed. A good blackboard should be placed on one side of the room, so that the laboratory instructor can be sure that each student is intimately familiar with the various connections he may desire to make on any of the equipment in line with the work given in the instruction sheets. Great stress should be laid on trouble-finding on lines, control boards and in motor windings. Laboratory work such as outlined should prove an invaluable aid to the electrical employes of any plant.

2—Arrangement of Students Into Classes.

Under this heading only two general principles can be given: the first is, that large classes must be homogeneous if good results are to be obtained. Where a group of students are of different degrees of ability and advancement, the class can do little work as a unit; a great amount of individual work is required and individual instruction can only be satisfactorily given when the classes are small. The committee would recommend that the size of the electrical classes be limited to about 15 men.

3—Hours of Instruction.

The majority of the companies from whom replies were received conduct their classes during working hours and pay the regular price of wages for the time spent in class rooms. The experience of the committee indicates that one and one-half hours of concentrated effort on the part of each student is the available maximum class period in all subjects except drawing or where laboratory work is done.

B—The educational committee proposes to make the course for the electrical students extend over a period of two years, starting September 15 to June 15. Entrance to this course will be had by application to the department superintendent, who if he thinks advis-

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able will give a short examination to determine the student's fitness or ability for entering the electrical school.

C—Subjects of Instruction.
1—First Year.
1—First Year.
  b—Magnetism.
  c—Line and resistance calculations.
  d—Diagrams and blue-print reading.
  e—DC. machinery, motors and generators.
  f—A-C. machinery, motors and generators.
  g—Inside wiring.
  h—Conduit work.
  i—Automatic control.
  j—Methods of braking.
2—Second Year.
  a—Power station layouts.
  b—Switchboards and wiring of same.
  c—Laboratory work.
  1—A conduit job complete.
  2—Meter repairing and testing.
  3—Motor testing and connecting.
  4—Automatic control boards.
  a—Test board for trouble.
  b—Connect up a board complete.
  5—Curve drawing instruments.
  6—Illumination tests and calculations.
  a—Typical example of mill building lighting.
  7—Meter transformers and connections.
  8—Armature winding.

D—The committee feels that a complete set of sheets, giving practical electrical problems, explanations, etc., on each of the above subjects should be made up and given to each of the students—therefore no text books will be required. The instructor can then use these sheets as a guide and make use of numerous other similar problems and questions.

A course of systematic electrical instruction for the electrical department employes of each plant made up along the above lines suggested, should prove very satisfactory and efficient and should successfully meet the needs of our electrical departments for training young men for their work.

Experience has taught us many things, which in this case is the need of training our electrical employes. It is coming to be a well accepted fact, that the nations which will most successfully contend for power and leadership in the future will be the nations which will develop their resources, train their young men and inaugurate co-operative systems.

In conclusion the educational committee strongly urges that the members of this association take definite action on the adoption of some course of instruction for the electrical department employes, as we all know that the demand for trained electrical men is now far in excess of the supply.

Turbine Gives Additional Line Shaft Power

Possibilities for Expansion of Existing Plants by the Use of Exhaust Steam in Low-Pressure Turbines and Resultant Low Operating Cost — Efficiency of Reduction Gears.

Electric motor drive the simplest solution to additional power supply problems is oftentimes not available to mill owners, whose plants are driven by line shafts. Ofter, however, there is sufficient boiler capacity in his plant to do the work, if it is effectively applied. Particularly where line shaft drive to a small number of machines is used. The installation of a turbine with speed-reducing gears is an ingenious solution to the problems.

A unique line shaft drive, consisting of a Westinghouse low pressure turbine and a Westinghouse daubee reduction gear has been installed in a Western Pennsylvania paper mill. There are two main line shafts to which the machines are belted. To one of the line shaft are belted two cutters, 10 beaters and one Jordan, an identical equipment, with the exception of the cutters, is belted to the other shaft.

Only seven of the 10 beaters, under ordinary running condition are in operation at one time, and these with one Jordan, require about 600 horsepower. An additional 20 horsepower for the rag cutters.

Heretofore, these two line shafts were each driven by a non-condensing reciprocating engine. However, one of these engines was wrecked and so necessitated the obtaining of a drive to replace it, at the least ultimate expense.

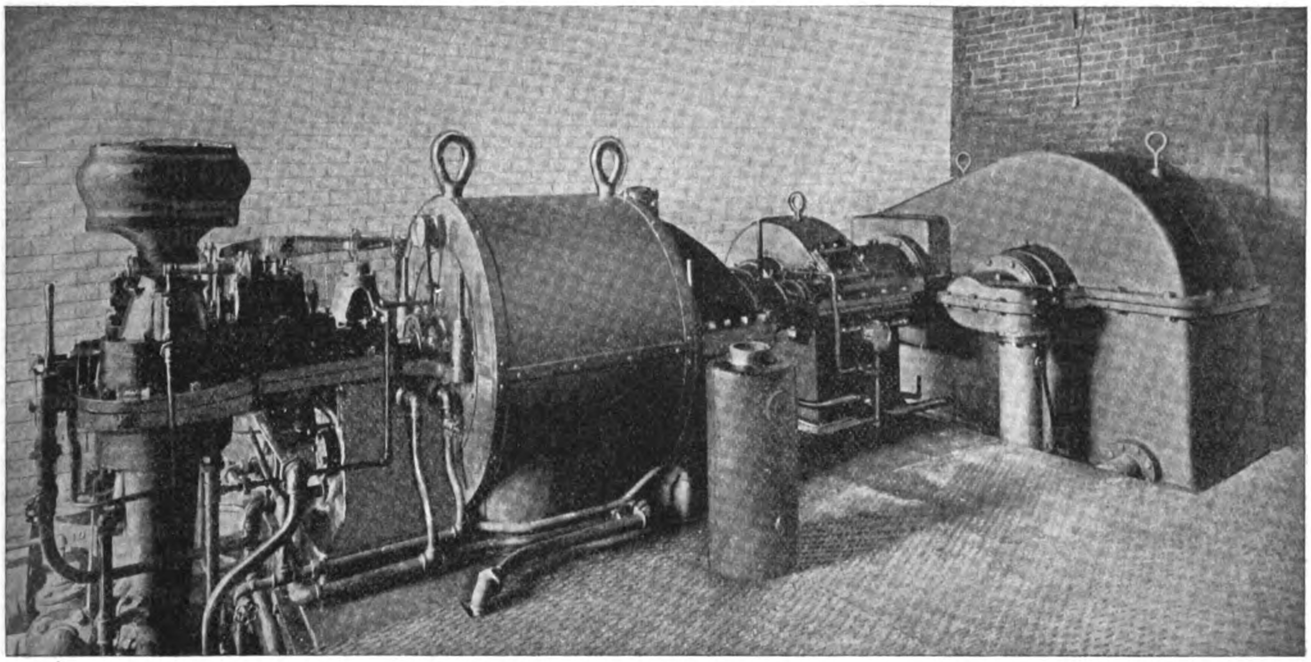
It is interesting to note the considerations entering into the final selection of the new drive. These conditions were somewhat as follows: Two 100-horsepower non-condensing engines turned the rolls and gave practically all the exhaust steam necessary for feed water heating, so that all the exhaust steam from the 700 horsepower non-condensing Corliss engine driving one of the line shafts, would have to be discharged to the atmosphere, unless some means were provided for abstracting the energy still available in it. A low pressure turbine was the logical prime mover, without a doubt, but it would have been of little use, on account of its high speed, had there not been a reduction gear to receive the power generated and to deliver it to the line shaft at low speed.

Other types of drives were considered, but each had inherent characteristics which disqualified it. For instance, a duplication of the old reciprocating engine was stepping back into the old rut, with the inevitable wasting of exhaust steam. A condensing engine would have been expensive, and no material improvement. Again, an electric motor, while comparatively cheap to install, would have been much more expensive, when the electric power bill was added to the cost of energy lost in wasted exhaust steam. And finally, it was still more expensive to install a turbine generator and an individual electric drive, because the existing equipment was of an entirely different character. However, in a new plant, where all equipment is being installed for the first time, the individual electric drive is by far the best, for reasons too well known to need discussion here.

A few approximate figures show more clearly the fitness of low-pressure turbine for this application. The exhaust steam from the 700 horsepower Corliss engine was more than sufficient to give 600 horsepower in the low pressure turbine. The engine takes steam at 150 pounds pressure, and exhausts into an oil separator at a back pressure, depending on the load, from 0 to 4 or 6 pounds, which is approximately the pressure of admission to the low pressure turbine. The steam is then expanded in the turbine down to a vacuum corresponding to 27½ inches of mercury referred to a 30-inch barometer, the vacuum being maintained by a Westinghouse-LeBlanc low level jet condenser and air pump. The pumps are centrifugal and are driven by a small turbine through a reduction gear. They take their water from a nearby creek and discharge it from the condenser into a reservoir at an elevation of 45 feet, which water is used in the manufacturing processes. The small turbine runs non-condensing, and its exhaust steam goes to the feed water heater, so that only part of the heat energy in the steam used by it can be charged to the turbine, and even that cannot be charged against the main turbine for it is used to do work in elevating the discharge water from the condenser to the reservoir and should be charged against the total cost of manufacturing. In brief, it may be said, that this paper company actually gets 600 horsepower without paying a cent for steam, and that it is using just one-half the steam they formerly used with two reciprocating engines to obtain the same power.

While this particular mill was not enlarged, it is evident that with a given amount of exhaust steam, either from non-condensing engines or condensing engines run non-condensig, a large increase of power is made available by the installation of a low pressure turbine. Further evidence of this possibility for expansion is the fact that in this paper mill when the two line shafts were driven by non-condensing reciprocating engines, a battery of 13 boilers was required, whereas, now only eight boilers are required for the maximum load.

So far this has been a discussion of the application of a low pressure turbine, but the means of transmitting its high speed power to a slow speed line shaft is fully interesting and as important. The change in speed is made by means of two reduction gears because the first cost of a single gear and pinion of ratio 36 to 11 would be prohibitive, and the gear would be very large and unwieldy. The first speed reduction, 3,600 rpm, to 720 rpm, is made with a fixed bearing type of reduction gear, the gear shaft of which is direct connected to the pinion shaft of the second gear which reduces the speed from 720 to 103 rpm.



View of turbine and reduction gears.

This larger reduction gear is of the flexible pinion frame type, better known as the Westinghouse I-beam type. It is this I-beam feature which makes the application of the geared drive possible.

In this, the pinion is supported on three bearings in a frame. This frame is supported under the middle bearing on an I-beam at right angles to the pinion axle. The flexibility of the web of this I-beam support allows the pinion to tip slightly and to let the teeth of the pinion line up with those of the gear. This lining-up is entirely automatic and instantaneous in operation, so that no mechanical complications are encountered, and no adjustments from the outside of the gear case are necessary at any time.

Both reduction gears are lubricated by sprays of oil directed upon the teeth just before the mesh. The pressure is maintained by a pump geared to the gear shaft, as shown in illustration. This pump also supplies oil under pressure to all the bearings in the two reduction gears. For starting, a hand pump is provided which insures a plentiful supply of oil on the bearings and teeth.

It may be asked why a fixed bearing type of reduction gear was used in one case and an I-beam in the other. It was a question of tooth pressure which determined the design. Take for instance a pinion transmitting 600 horsepower at 3,600 rpm, which was the case of the first reduction gear in the particular installation under discussion. If the same pinion were to turn at 720 rpm and with the same tooth pressure (i.e., pounds pressure per inch) of tooth face it would be capable of transmitting one-fifth of 600 horsepower, or 120 horsepower only. It follows, then, that the second gear would have been made five times as large as the first of the same type had been used, and for the transmission of the same amount of power. Such reduction gear would have been large and bulky. It would also have been costly, because cost is a function of size.

In order, then, to make a reduction gear which would be within reasonable limits as to size, and at the same time marketable, the allowable tooth pressure had to be increased, or in other words, the factor of safety included in the allowable stress in ordering fixed bearing design, had to be lowered. But if this were done, some other safety factor would have to be incorporated to insure reliability of operation, otherwise, a slight misalignment of the teeth and uneven distribution of tooth pressure would have resulted in a failure of the gear.

This safety factor was found in the Westinghouse I-beam support for the pinion which corrects any misalignment and uneven pressure distribution which might otherwise exist. Misalignment might have been due to temperature changes, slight, but unavoidable inaccuracies in workmanship, or distortion of the bearing supports in the housing, due to varying loads or changes in foundations, and if not corrected, would have caused the total tooth pressure to be concentrated at one part of the tooth which would have overstressed that part of the tooth and have caused it to fail.

In the case of the reduction gear with fixed bearing support for the pinion, misalignment, although practically prevented by good workmanship, will not have disastrous results if it should exist, because of the high factor of safety used in the tooth design. In other words, localization of total tooth pressure would not stress the metal beyond a safe limit.

The self-aligning feature, the forced lubrication, the rugged construction of the parts, and the workmanship on these reduction gears make them a very efficient and reliable means of transmitting power. The actual efficiency of the two gears together, is 97 per cent, showing that only 3 per cent of the total power transmitted is lost in them. This energy is dissipated in the form of heat, and is taken up by the oil, which in turn, is cooled by a water cooling system. As to reliability, in the paper mill under discussion, the double reduction gear has run 24 hours per day, six days per week, under maximum load, and it has never been shut down on account of trouble with the gears.

In conclusion, we might review the chief points brought out in this article. The fundamental one is efficiency of Westinghouse I-beam reduction gear, as applied to line shaft drives; the possibilities for expansion of existing plants by the use of exhaust steam in low pressure turbines is another; and, finally the remarkably low operating cost through this application.

Comment on Present Electrode Situation

Tremendous Increase in Electric Steel Production Has Placed Demand on Electrode Manufacturers in Excess of Production Capacity — Fundamental Principles of Electrode Manufacture.

Developments during the past two months, in the electrode situation have made this subject of considerable interest to both the manufacturer of the electric furnace and the producer of electric steel. The tremendous increase in electric steel production, largely brought about by war demands, has resulted in a great increase in the electric furnace industry without a corresponding increase in the production of electrodes. This has resulted in a shortage of the latter commodity, not due to any shortage in raw materials used in their manufacture, but simply because the electrode industry has not kept pace with the demand.

Sometime ago the chemical and explosives division of the War Industries Board issued a statement discouraging the starting of new electric furnaces, explaining that electric steel production is now somewhat in excess of the demand. New electric furnaces were, therefore, discouraged, due in part to the above fact, but chiefly for the reason that the electrode situation was critical.

It may be possible, although questionable, that the production of electric steel is in excess of the demand, but it is worthy of consideration that even if this fact were true, that the electric furnace is relieving the open hearth and the Bessemer converter. One manufacturer of electric furnaces emphasizes this point: "The more electric furnaces placed in operation producing steel which can be turned out either in the form of high grade alloy and tool steels or high grade steel castings. the more will the open hearth and Bessemer capacity be available for the manufacture of plates, structural steel and the other more common grades which are so much needed. And in the steel casting field will be released similar capacity for the manufacture of heavy castings when weight is the chief essential, or for the manufacture of ingots."

It seems reasonable that the continued and even the increased production of electric steel is very essential, and therefore the logical procedure in overcoming the difficulty would seem to be to increase electrode production. There is nothing extremely complicated about manufacturing electrodes, nor are any of the raw materials difficult to secure. Either the present manufacturers will have to increase their capacities, or new enterprises promoted. In this connection it is interesting to note that one steel plant in the Pittsburgh district has already sought to solve the problem by manufacturing their own electrodes. A plant was erected at the cost of about $400,000, and according to all reports the experiment is proving successful. It is possible that providing the steel industry finds it profitable that the practice of manufacturing electrodes by the consumer may grow in popularity. On the other hand there would be the usual reluctance in taking up the problem of manufacturing a product which is decidedly a side issue. Thus the steel producer would simply be burdening himself with one more problem. The by-product coke oven is of course, similar in the light of being a side issue although of vastly greater importance, and has more reasons to justify its being taken up by the steel producer himself. The chances, therefore, are not very great that the experiment being conducted in Pittsburgh will be generally adopted.

Among electric furnace manufacturers and users there is no disposition to criticize in any way the quantity of production of the electrode plants. It is generally felt that they are doing even more than could reasonably be expected in view of the extremely abnormal situation.

Looking at the situation from all sides, it would seem then that the logical solution would be to encourage the increase in capacity of the present electrode plants. This would be preferable to starting new enterprises, if for no other reasons than that the present producers have proven their merit, whereas new producers would be subject to the experimental erors usually evident in any new industrial organization. even if the commodity produced is a product whose production methods are well known.

It might be of interest to mention some of the more important processes entering into the manufacture of the carbon electrode. The pioneer work was done by a Frenchman, Carré, about 1876. He at that time outlined the principal steps as grinding, mixing with a binding medium, pressing and afterwards heating to incandescence. At this time, however, the chief demand was for use in electric arc lights. The chief raw materials used are: coke, charcoal, anthracite, lamp black, retort carbon, tar coke, petroleum coke and graphite. In some cases extensive equipment is required for graded crushing, grinding and screening. After crushing the material is mixed with the binding medium, usually tar or pitch, and then kneaded or mixed in steam-jacketed mixers. Before mixing. however, the raw materials are subjected to calcinations to remove gases and oily substances.

The material is then pressed, sometimes in extremely large presses (according to the size of the electrode), to the form required. Roasting and coking processes are then applied to the pressed pieces in kilns or furnaces. The electrodes are placed into square or round chambers and packed with carbon dust to exclude the air during calcination which lasts from 6 to 12 days for smaller pieces and from 10 to 16 days for larger ones. During the early part of calcination the tar oils in the binding medium distill off, following this the binding medium cokes and the entire mass slags. Great care must be employed in heating the electrodes uniformly in order to avoid stresses.

From a translated article originally appearing in Stahl und Eisen the following values for the physical and chemical qualities of amorphorus carbon electrodes, are given:

Specific weight	1.50-1.55
Specific resistance at cross-sections of from 25 to 3,000 sq. cm.	45 to 100 ohms
Electrical coefficient of temperature of from 25° to 900° C.	0.000318
Specific heat at 100° C.	0.18-0.22
Compressive strength	230-410 kg/sq. cm.
Bending strength	51-81 kg/sq. cm.
Heat extension from 0-700° C.	0.26% of the initial value
Heat conductivity for a cube of 1 cu. cm. at temperature falls from 130-20° C	0.24 heat unit/st.
Ash content	2.5 -3.0 %
Phosphorus	0.45-0.53%
Sulphur	0.91-1.10%

American Foundrymen's Association Meeting.

At Milwaukee, during the week of October 7, will be held the greatest gathering of metal manufacturers ever assembled in this or any other country. Simultaneous meetings will be held by the American Foundrymen's Association, Iron and Steel section of the American Institute of Mining Engineers, Institute of Metals division of the American Institute of Mining Engineers, and American Malleable Castings Association.

PRODUCTION TOPICS

HOW BEST RESULTS CAN BE OBTAINED WITH CARBON BRUSHES.

The writer does not intend to go into detail in the explanation of carbon brushes, but does wish to bring before you the important items in ordering them which is very essential in these busy times.

Carbon brushes, while they are only a part of the electrical motor or generator, are really what the nerve center is to the body. With the improper brush installed upon a motor or generator we readily find that there is more or less trouble. The manufacturer tries in every respect to give the operating man the best and most suitable brush for his equipment, but often the operating man will send in a requisition for brushes giving the size, style of shunt and nothing else. While this information is very valuable to the manufacturer, he is at a loss to know for what service these brushes are to be used. The brush manufacturers cannot, in every case, correspond with the operating man thereby holding up his order and delaying shipment, so naturally the best course is followed and the brush that is supplied is nothing more than a guess-work proposition.

When ordering brushes, in addition to the size and the style of shunt, the following information should also be given: bevel, if any, ampere carrying capacity of machine, number of brushes required for motor or generator, the speed under which the machine is operated, and it is also very important to know whether the commutator is undercut or flush mica. Also, if possible, service under which this machine operates should be given. This will give the manufacturer of brushes a good idea of what is required and with the engineering forces now employed, a reasonably sure recommendation can be made of the proper grade.

The operating man often condemns a certain brush manufacturer for this or that or other reasons, and when these reasons have been solved, it has been found that really insufficient information has been given to the brush manufacturer so as to enable him to be able to select the proper grade of brush for his equipment.

A number of large manufacturers of carbon brushes are taking upon themselves the responsibility of proper selections of brushes and are going into the mills and gathering data on the entire operations and equipments of that mill. This, of course, saves the operating man the inconvenience when ordering brushes in giving detailed information on each order. By getting this data, all that is necessary for the operating man to do is to specify for what sheet or sheets his particular order or orders refer to. It can readily be seen that by doing this the manufacturer has before him a sheet showing just for what service the brushes ordered are needed and he also has before him the recommendations made by the engineers who obtain the data from the mills. It might be well to state that a number of mills at the present time are using this data sheet system.

OXYGEN IN IRON.

The subject of determination of oxygen in iron by heating drillings to redness in a current of pure, dry hydrogen which gives only the amount which is present as iron oxide; occluded oxygen and oxides of other elements (manganese, silicon) are not affected, is discussed by F. Schmitz in a recent article in "Stahl und Eisen." The apparatus recommended for the determination comprises a hydrogen cylinder from which the gas passes in succession through two wash-bottles containing alkaline pyrogallol and one containing concentrated sulphuric acid, an unglazed porcelain tube containing fine iron drillings heated in an electric furnace, and two U-tubes containing phosphorus pentoxide. The purified gas then passes over the drillings of the sample to be analyzed heated in a Mars electric furnace, and through a U-tube with phosphorus pentoxide and a sulphuric acid guard tube. Hydrogen is passed through the apparatus for an hour, after which the temperature of the furnace is raised to 850 degrees to 900 degrees C. in half an hour. The following results of oxygen estimations are given: gray cast iron, 0.001—0.005 per cent; Swedish white iron, up to 0.002 per cent; spiegel, 0.008—0.110 per cent; silicospiegel, 0.037 per cent; ferro-tungsten, 0.058 per cent; high-speed steel, 0.024 per cent; nickel-steel (0.45 per cent C, 25 per cent Ni), 0.020 per cent; ingot iron, 0.031 per cent; crucible steel (1 per cent C), 0.24 per cent; wrought iron, 0.217—0.244 per cent. The oxygen content of basic steel just before the addition of the "killing" elements varied from 0.066 to 0.112 per cent, while after these additions the oxygen present had fallen to 0.014—0.040 per cent. The highest oxygen content ever found by the author in badly overblown basic Bessemer steel was 0.113 per cent, corresponding to 0.51 per cent FeO.

SULPHUR IN BASIC BESSEMER PROCESS.

Contrary to the experience of Hilgenstock, who found that on the average 58 per cent of the sulphur present in the charge could be removed in the basic converter (one-twelfth during the decarburization, one-third during the after blow and one-sixth by the manganese additions), L. Blum explains in "Stahl und Eisen" that he only succeeded in removing one-third. With a mixer iron containing 0.4 per cent Si 28 per cent of the sulphur passed out of the metal, but when 1 per cent Si was present this percentage was much reduced, and at times even an increase of sulphur occurred. This was traced to the lime added, which contained from 0.33 to 0.69 per cent SO_3. During the first minute or two of the blow, while the lime additions are being dissolved and the silicon is being oxidized, a silicious slag is formed and the following reaction occurs: $CaSO_4+4Fe=FeS+3FeO+CaO$. As the lime additions become incorporated in the slag this sulphurization stage passes into one of desulphurization, which, however, can never be complete; it is most effective during the last few minutes of the blow. A high silicon content in the original charge results in a longer period during which sulphurization can occur, with a corresponding reduction in the desulphurization stage. A lime low in sulphur should be used. The percentage desulphurization is higher as the sulphur content of the charge rises. It is not good practice from the point of view of desulphurization to produce pig iron high in silicon merely to obtain more complete reduction of the manganese in the ore. The harmful effect of the silicon more than counterbalances any benefit derived from the manganese.

STEEL MEN WANTED.

The metallurgical branch of the ordnance department, engineering division, is seeking a number of men for important metallurgical work who have had steel mill experience. Requests for further information should be addressed to Lieut.-Col. H. W. Reed, office of the chief of ordnance, engineering division, Washington, D. C.

NEWS OF THE PLANTS

The Trumbull Steel Company, Warren, O., is now operating five open hearth furnaces, each with capacity of 100 tons a day. Two additional furnaces, in course of erection, are expected to be in operation at an early date, making a total battery of seven at the works. A new blooming mill is also being installed, while a number of the sheet mills are being converted into tin mills. In the future about 10 sheet mills and 23 tin plate mills will be in operation at the plant, the latter with capacity of about 125,000 boxes of tin plate per month. The company has arranged to increase its outstanding common stock by $2,000,000, or to a total of $8,000,000.

The plant and properties of the Georgia Steel Company, Rising Fawn, Ga., including blast furnace, mills, iron ore lands and manganese ore lands in Bartow county, have been purchased at court sale by Joel Hurt, Atlanta, Ga., and associates, for a consideration said to be $400,000. It is understood that the new owners plan to operate the plant, developing the iron ore and other properties.

The Fulton Steel Company, 149 Broadway, New York, has broken ground for the construction of a number of additions to its steel plant at Fulton, N. Y., to increase the present capacity many fold. Several large buildings will be erected on Division street, including rolling mill, annealing furnaces, electric furnace and other structures. The electric furnace, of six-ton capacity, will be placed in operation at an early date. The different buildings are estimated to increase the present output of the plant by about 400 per cent. The entire works will be devoted to the production of the highest grade of steel for government service, the plant for some time past having been on a 100 per cent war basis. The new extensions are estimated to cost in excess of $100,000 and will be built by the Levering & Garrigues Co., contractors, West Twenty-third street, New York. H. C. Beaver is president of the steel company.

The Heyward Steel Company, New Cumberland, W. Va., recently incorporated with a capital of $250,000, is having preliminary plans prepared for its proposed new steel plant, to be erected in this district. Headquarters will be established in the Farmers Bank Building, Pittsburgh, Pa. H. C. Higbee, H. B. Holland and T. L. Ernst are the incorporators of the company.

The munitions division of the Laclede Gas Light Company, St. Louis, Mo., has taken bids for the construction of a shell manufacturing plant for government service, to be erected on Broadway, at a cost of about $700,000. The works will be equipped for the production of 155 and 240 mm. shells, including hydraulic press department for shell forgings, machine works with engine and other type lathes for machining of shells, and other machinery. At its Manchester plant the company is considering the erection of new buildings for the manufacture of shells, to cost about $500,000. This plant will also be fully equipped in various departments for every feature of steel shell production. J. A. V. Scheckenbach is superintendent of construction.

The Birmingham Steel Corporation, Birmingham, Ala., recently incorporated with a capital of $1,000,000 under Delaware laws, has filed notice of increase from $1,000,000 to $5,000,000, to provide sufficient working capital for its proposed new steel works. The company has broken ground at North Avondale, near Birmingham, for this new plant, with the first unit designed to cover an area of about five acres of property. It is proposed to push construction to allow for the installation of machinery shortly after the first of the year, with the plant operating within five months. The works will produce a large quantity of fabricated steel sections for the Mobile Shipbuilding Company, Mobile, Ala., Henry Leon Brittain being president of both organizations. C. S. Bergendahl is chief engineer for the company.

The Gerson Iron & Metal Company, Birmingham, Ala., has acquired the plant of the East Birmingham rolling mills, East Birmingham, consisting of rolling mill and other structures. The new owner proposes to operate the works for the production of bar iron for the government, and will increase the daily capacity, which now averages about 30 tons, to an output of 50 tons.

The Woodward Iron Company, Birmingham, Ala., is completing final details for the proposed new steel works, to be built in this section in conjunction with the government. The plant, as now planned, is estimated to represent a total investment of approximately $25,000,000, and will be used, it is understood, exclusively for the production of steel for government service. It is said that completed details of the new works will be available in October. Frank Crockard, formerly vice president and general manager of the Tennessee Coal, Iron & Railroad Co., and later president of the Nova Scotia Steel & Coal Co., has become president of the company, and will give personal attention to the proposed new steel plant. A. H. Woodward is chairman of the board. The headquarters of the company are at Woodward, Ala.

The Bethlehem Steel Corporation, South Bethlehem, Pa., has awarded a contract to the Deverell-Spencer Company, Garrett building, Baltimore, Md., for the construction of two large additions to its steel works at Sparrows Point, Md. The structures will be each three-story, about 275 x 1,150 feet, of brick and concrete, and will be used for increased capacity. These buildings inaugurate the proposed extension plans of the company, recently announced, with a total of about $50,000,000 available for this purpose, and of which amount the government, it is understood, will advance $20,000,000. The later extensions to the works will include new blast furnaces, coke works and other structures.

The Newport News Shipbuilding & Drydock Co., Newport News, Va., has awarded a contract to the Mellon-Stewart Company, New York, for the construction of its proposed new boiler works, to be erected in conjunction with the government on the James river, near Richmond, Va. The buildings are estimated to cost about $1,000,000, exclusive of machinery and equipment, which will cost close to $2,000,000 in addition. The initial works will consist of a main manufacturing plant, about 105 x 600 feet, to comprise boiler and plate shops, machine shop and foundry. A number of smaller buildings will be erected to include power plant for works operation and other auxiliary departments. The plant will specialize in the construction of Scotch marine boilers for installation in government vessels now being built in this district.

NEW COKE PLANT.

The Texas Steel Company, Beaumont, Tex., has acquired extensive coal properties on the Warrior river, in the vicinity of Birmingham, Ala., and in connection with extensive coal mining work, is planning for the construction of a new coke works, to be used in connection with its iron furnace and proposed new steel works. A large battery of ovens, it is understood, will be installed a site near the river, allowing the shipment of the coke to Beaumont by barges.

Some Pointers on By-Product Coke Oven Operations

THE BY-PRODUCT COKE OVEN: ITS PRODUCTS.

By William H. Blauvelt.*

Before the general use of the by-product oven, benzol and its homologues, toluol and xylol, or solvent naphtha, were produced from the distillation of tar, which usually contains about 3 per cent of these compounds. Now the main source of supply is coke-oven gas, from which the benzols are scrubbed by bringing the gas into contact with a heavy oil of petroleum or tar. This process is usually carried on after the removal of the ammonia. The benzolized heavy oil is distilled to drive off the benzols and the heavy oil is cooled and returned to the heavy-oil scrubbers. The benzols are recovered in the form of a "light oil," containing usually about 60 per cent. of benzol, 12 per cent of toluol, and 6 per cent of solvent naphtha, although these percentages vary considerably with the details of the coking process and the light-oil recovery.

Before the war the light oil produced was used largely for enriching illuminating gas, and the refined products were employed in the manufacture of paints, varnishes and other similar industries. At that time many plants were not equipped to recover light oil. Since the beginning of the war the enormous demand for the high explosives, picric acid and trinitrotoluol, familiarly known as T. N. T., has resulted in the equipment of practically all the plants in the country for the recovery of these products. It is estimated that the plants now built or building have a capacity of 101,500,000 gallons (384,212,000 l.) of light oil per year. For the production of these explosives the benzol and toluol have to be thoroughly refined by washing in sulphuric acid and by accurate fractionation, which processes require skillful supervision. The removal of the light oils from the gas practically destroys its luminosity, but the reduction in calorific value is relatively small, about 10 B. t. u. per cubic foot per gallon of light oil recovered per ton of coal.

When the demand for high explosives ceases after the war a large amount of the benzol now produced will probably be sold as motor benzol. This product is usually a mixture of benzol, toluol and solvent naphtha in the proportions in which it occurs in the light oil, and it is obtained by a comparatively simple process of refinement from the light oil. Motor benzol has a fuel value from 18 to 20 per cent higher than gasoline, and may be used alone with the ordinary carburetor if a somewhat larger proportion of air is used, or it may be mixed with gasoline in any proportion. Pure benzol freezes at 5.18 degrees C., and toluol at 180 degrees C. No trouble is experienced from freezing, even in the coldest weather, when proper percentages of toluol or gasoline are mixed with the benzol.

The dye and color industry in the United States has greatly expanded during the war, and it will flourish after peace has returned if given proper government protection. This will furnish a large market for benzol, which is the raw material for aniline. Also it seems not improbable that trinitrotoluol will be widely utilized as an industrial explosive. It is claimed that it can be manufactured more cheaply than nitro-glycerine, and as a commercial explosive it has many advantages over nitroglycerine compounds.

Trinitrotoluol is very stable and ignites only at high temperatures, and even then it does not explode. It does not freeze, as does nitro-glycerine, and on many counts it has advantages on the side of safety and convenience. When used alone it produces large amounts of carbon monoxide; but this can be entirely prevented by combination with other bodies, such as ammonium nitrate for example, if these are added in proper proportion to produce complete combustion.

From the above brief discussion of the development of what has grown to be one of the important American industries, it will be seen that the by-product oven has given this country something which is much more than merely a cheaper method of producing coke. It gives the coke user a material which can be accurately adapted to his special needs by an intelligent application of the several variables that may be introduced into the coking process. It renders available many coal deposits not heretofore considered suitable for making coke. It furnishes a new and large supply of gaseous and liquid fuel for metallurgical, industrial and domestic uses. It adds very greatly to the supply of available fertilizers which our overworked and underfed lands are coming to need so sadly, and it furnishes an abundant supply of raw materials for a number of our chemical industries, especially the great dye and color industry which our war experience has shown is vital to a large number of our manufacturing operations. It is hard to suggest any other industry of comparatively recent introduction which does more to conserve the natural resources of our country, which we are only beginning to realize have any limit or require any consideration beyond the needs or desires of the present moment.

NEW GAS WASHING AND DRYING INSTALLATION.

Freyn, Brassert & Co., engineers, 643 Peoples Gas Building, Chicago, have been awarded a contract by the Carnegie Steel Company, Homestead Steel Works, for the installation of a Brassert gas washing and drying unit for one of their Carrie blast furnaces. This unit, which will be built immediately, brings the total number of Brassert gas washing and drying units installed or in the course of construction to 63. The Carnegie Steel Company has also placed a contract with Freyn, Brassert & Co. for the installation of a Dorr thickener in conjunction with this gas washing unit for the clarification of the waste water and recovery of the suspended flue dust. A similar installation is now in operation at the South Works of the Illinois Steel Company and another one being furnished to the Southeastern Iron Corporation at Goshen, Va.

STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF

The Blast Furnace and Steel Plant

[Required by the Act of Congress of August 24, 1912]

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Business Manager—Fred C. Andresen, 108 Smithfield street, Pittsburgh, Pa.

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E. B. Horne, 1516 Helen avenue, Detroit, Mich.
Fred C. Andresen, 108 Smithfield street, Pittsburgh, Pa.
R. E. Densmore, Cleveland, O.
Mary A. Howe Estate, Pittsburgh, Pa.

Known bondholders, mortgagees, and other security holders, holding 1 per cent or more of total amount of bonds, mortgages, or other securities: None.

FRED C. ANDRESEN, Business Manager.

Sworn to and subscribed before me this 20th day of September, 1918.

JOHN N. ENGLISH, Notary Public.

(My commission expires March 9, 1919.)

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*Last installment of paper read by author before A. I. M. E. meeting.

INDUSTRIAL SAFETY

ELECTRICAL HAZARDS AND STANDARDS.

By M. G. Lloyd, M. D., Electrical Engineer.

The electrical accidents to which persons are subject can be largely grouped in two classes: those due to receiving a shock, and those due to burns from arcs, short circuits, etc.

The most obvious way in which to avoid a shock is to so isolate the conductors which carry dangerous voltages that they will always be out of reach. In outdoor work we do this by placing the wires underground or overhead. That is sufficient if they are maintained in such a position, but we know that overhead wires sometimes come down or come in contact with other conductors. For safety, then, it is necessary that both the conductors and the structures which support them be strong enough, and have sufficient clearance. The hazard from a conductor coming down is especially great where they cross over other wires or over railroad tracks, or where it is upon the street of a congested city. It is consequently more important to secure ample strength of construction in such places.

Where conductors charged to high voltage are not out of reach warning signs should be placed, and if possible some form of guard should be erected to prevent one from easily making contact with it.

Where conductors cannot be kept isolated, actual contact with the wire can be avoided by covering the latter with some insulating material. For high voltages, however, it is not easy to provide adequate insulation and better practice is to use bare conductors which are placed where there is little or no danger of contact.

Various forms of protective devices may also be used to prevent contact with conductors at high voltages, for instance a lightning-arrester is used to discharge a conductor which is normally at a low voltage in case it becomes charged to a high voltage, by contact with another wire or through the effects of lightning. The use of remote-control apparatus is another means of avoiding the handling by persons of apparatus operating at high voltages. Cut-outs or fuses and circuit-breakers are devices which are used to disconnect a circuit when some abnormal condition is brought about. While their primary purpose is the protection of apparatus or of the circuits themselves, from overloads, they incidentally give protection to persons by their action in some cases.

To avoid burns from electrical causes, various procedures may be followed. One of these is to limit the current which may flow in a circuit by the use of automatic circuit breakers or other forms of cut-outs as mentioned before. Another is to place switches under oil so that an arc will not be formed when the circuit is broken. Switches and fuses may be simply enclosed so that contact with molten metal, or with an arc, where one is produced, is rendered impossible.

The matter of enclosing fuses and switches is a very important one. It is preferable always to have them enclosed and to have fuses so protected by a switch that they are dead whenever they are being handled. A man should never find it necessary to insert a fuse in a live circuit, for if the fuse should blow while it is in his hand he would be very likely to be burned. It is also preferable to have switches enclosed even for operation at low voltages, so that it is not easy to come in contact with any live parts of the switch. Above 150 volts there is considerable danger of shock if good contacts are made with live conductors and fatal accidents have been known to occur even when the voltage was below 150 volts.

The danger of coming in contact with a high-voltage conductor is in having the electric current traverse the body and, of course, this will ordinarily take place when there is a simultaneous contact with the ground, or with the opposite side of the circuit in question. Unless one is on a platform or some insulating body, a contact with ground is almost always possible. The ground may be good or poor according to the conditions.

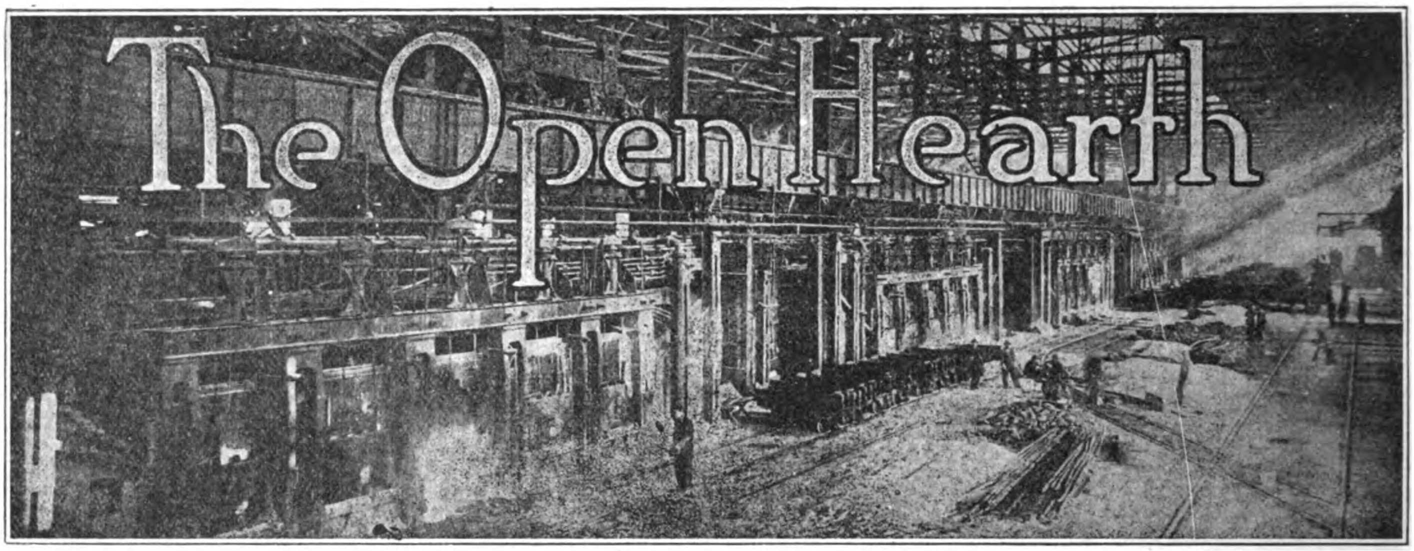
Grounded conductors sometimes offer a hazard greater than if they were absent. On the other hand, we can hardly avoid the presence of grounded conductors when our gas and water pipes and parts of our building construction are conducting and are grounded. Such conditions are present in every residence and in every factory. The greater safety, consequently, seems to lie usually in having metal objects which are not supposed to carry current, but which may by any possibility be made alive, grounded. It is consequently a common requirement to have any conducting bodies such as the inclosure or guards of electrical equipment securely and permanently grounded, and in three-wire systems of wiring it is advisable always to ground the neutral conductor as this will make the voltage between the other wires and the ground as low as possible.

Many persons who have been shocked have lost their lives when their lives could have been saved if a proper application were made of some resuscitative process. Usually the life of a shocked person can be saved if the proper method is at once applied. Dr. Lauffer, of the Westinghouse Electric & Manufacturing Company has published a book on this subject which ought to be well known to every safety engineer or electrical engineer in the Pittsburgh district.*

The study and investigation of the bureau of standards lead to the formulation of rules covering the construction, installation and operation of lines and equipment. The tentative drafts of these rules were presented for criticism to various engineers and representatives of different interests concerned in this subject.

The National Electrical Safety Code consists of five parts. The first part deals with installations in central stations and sub-stations. Part 2 is concerned with outdoor electrical lines as constructed overhead or underground. Part 3 pertains to the installation of utilization devices, that is to say, it is concerned with the wiring, appliances and control apparatus installed in factories, residences and other buildings. Part 4 applies to the operation of electrical equipment. In addition to those mentioned there is a supplementary part giving rules to cover methods of grounding wherever such protective grounding may be called for in other parts of the code.

The only part of the code which has met with any appreciable opposition is the part dealing with the construction of overhead lines. Such opposition as has developed here has been due to the conflicting interests of the different utilities concerned, namely railroads, power companies and telephone companies. In order to formulate a general code which should cover all conditions it has been necessary to harmonize the demands of the different interests and to effect a compromise which would be fair to all and which would result in reasonable rules giving an adequate relief from accident hazard.



The Open Hearth

Guy E. Tripp, formerly colonel United States Army and head of production division, has been made brigadier general United States Army, and placed in offices having charge of the production of ordnance material in their respective sections of the country. The district chiefs will report direct to General Tripp, who is succeeded as head of the production division by Colonel C. C. Jamieson.

Previous to his connection with the Ordnance Department, General Tripp was chairman of the board of directors, Westinghouse Electric & Manufacturing Co., with headquarters in New York.

V V

W. L. Chatfield, superintendent of the Manufacturers' Foundry Company, has resigned to accept a position as foundry superintendent and chemist for the Kanawha Manufacturing Company, Charleston, W. Va.

V V

A. C. Callan, representative of the Pacific Coast Steel Company, with offices in the Oregon Building, Portland, Ore., has charge of the construction of its new steel plant at Willbridge, Ore.

V V

T. Finnegan has been appointed vice president, in charge of the Western district of the American Brake Shoe & Foundry Co., with offices at 332 South Michigan avenue, Chicago, Ill.

V V

J. J. Trefz, who recently resigned as superintendent of Anglo-American Mill Company, Owensboro, Ky., has been made general manager of the Southern Foundry Company of Owensboro.

V V

William M. Bailey has become vice president of the Fulton Steel Corporation, New York City. In his new capacity Mr. Bailey will have entire charge of the company's property and will be located at Fulton, N. Y. The Fulton Steel Corporation was organized last year and started the production of high speed steel in February. One electric furnace has been in operation and another was recently purchased. Prior to his connection with the Fulton Steel Corporation Mr. Bailey was secretary to the president of the Carnegie Steel Company, later held a similar position with the Midvale Steel Company, and later assissted to the president of the Midvale Ordnance Company.

V V

W. C. Bird, until recently chief clerk for the American Steel & Wire Co. at Waukeegan, Wis., has been transferred to the auditor in Cleveland. Mr. Bird is succeeded at Waukeegan by C. M. Diehl, formerly chief clerk at the wire works, Donora, Pa., who is succeeded by D. M. Stinson, formerly chief clerk of the plant at Allentown, Pa. J. B. McClure, general clerk of the accounting department at Donora, succeeds Mr. Stinson.

V V

George D. Brittain has been made treasurer of the Birmingham Steel Corporation. He was formerly secretary-treasurer of the Mobile Shipbuilding Company.

V V

A. S. Blagdon has resigned, the presidency of the American Malleable Company, Lancaster, N. Y., to become vice president and general manager of the Air Reduction Company. He was succeeded by Arthur Aigeltinger.

V V

Frank P. Case has accepted the position of general sales manager with Atlas Crucible Steel Company, Dunkirk, N. Y He formerly held a similar position with the Braeburn Steel Company.

V V

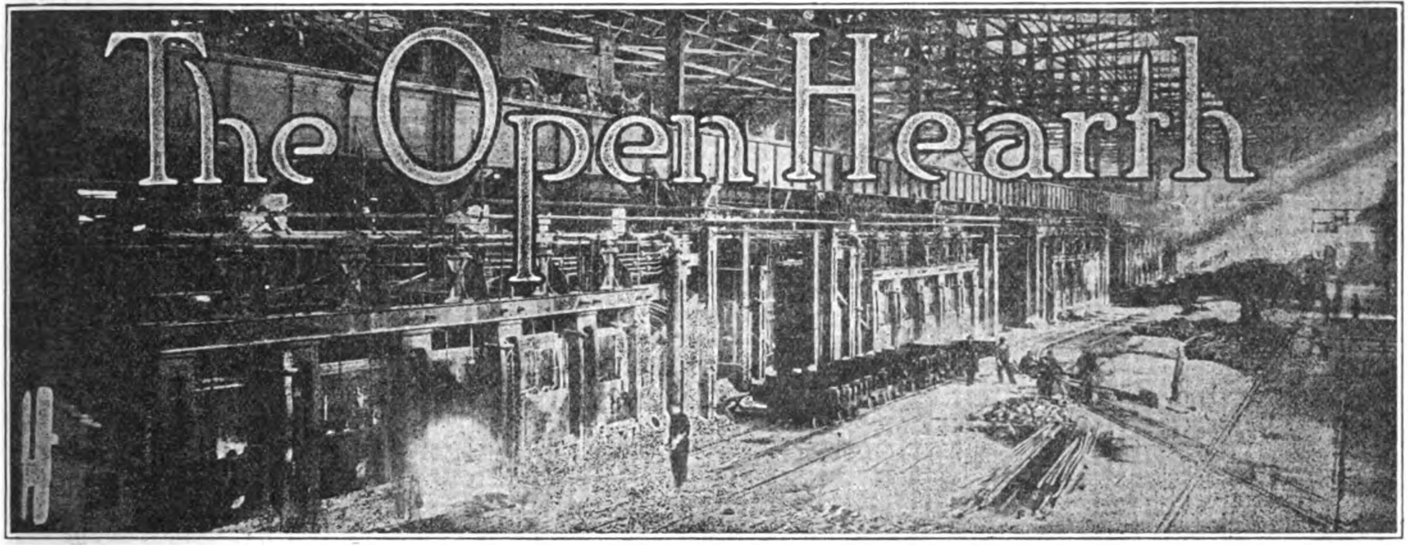
W. M. Faber, chief engineer of the American Steel & Wire Co., Cleveland, is leading the fuel conservation movement in Northeastern Ohio, where there will be 16 counties under his control.

V V

Ernest B. Talker has been appointed master mechanic for the Inland Steel Company of Indiana Harbor, Ind. He formerly held a similar position at the Federal furnace plant of the By-Product Coke Corporation, South Chicago, Ill.

V V

Fred W. Beach, formerly manager of the LaSalle Steel Corporation and general manager of sales of the Massillon Rolling Mill Company, has been appointed to represent the Betz-Pierce Company, Cleveland, jobber in steel in Chicago territory.



The Open Hearth

At the monthly meeting of the Pittsburgh Foundrymen's Association held on Monday evening, September 16, in this city, Major Joseph T. Speer, president of the Pittsburgh Valve Foundry & Construction Co. and a charter member of the association, was elected an honorary member. W. H. Stanton, National Iron and Steel Publishing Company, Pittsburgh, and A. P. Holland, Geauga Silica Sand Company, Cleveland, were elected members.

V V

George W. Hite has resigned his position as sales managed for the Pittsburgh Iron & Steel Foundries Co. and is located at Washington for the War Department.

V V

Charles McKinstry has been made hot mill superintendent to succeed E. A. Phelan, whose resignation became effective September 14. For the past 13 years Mr. McKinstry has been a roller at the plant of the Sharon Steel Company, Youngstown, O.

V V

Charles H. Tucker has resigned his position with the Toledo Bridge & Crane Co., and with William F. Billingsly and others have incorporated the American Crane & Engineering Co. It is reported that the company has a government contract for locomotive cranes.

V V

D. R. Fithian, formerly with the Youngstown Iron & Steel Co., has been appointed superintendent of the Hazelton works of the Sharon Steel Hoop Company to succeed Charles B. Cushwa: resigned. The position of district manager, held by Mr. Cushwa, will be abolished, and department heads in this district will report to G. W. Short, vice president and general manager of the company.

V V

Frank H. Crockard, president of the Nova Scotia Steel & Coal Co., who was formerly general manager of the Tennessee Coal, Iron & Railroad Co., has been invited to join the Woodward Company and is expected in Birmingham soon. The company is preparing its plans for a new steel plant.

V V

Harry L. Williams, one of the founders of Hickman, Williams & Co., has resigned as president and will devote himself to private interests. The firm has branches in many cities as furnace representatives and dealers in coke, ferroalloys, pig iron and other products, representing, among other interests, the Woodward Iron Company. T. Coleman Ward, vice president of Hickman, Williams & Co., succeeded Mr. Williams as president. In 1903 Mr. Ward was connected with Hickman, Williams & Co. as salesman in the Cincinnati office and continued in this position for three months; he was then transferred to the Pittsburgh office as resident manager. In 1913 he was made vice president of Hickman, Williams & Co. at Pittsburgh, a position he continued to hold until made president. Mr. Ward will continue to make his headquarters in the Henry W. Oliver Building in Pittsburgh.

V V

C. H. Benson has left his position as chief clerk in the operating department of the Republic Iron & Steel Co. to enter military service at Camp Wadsworth, S. C.

V V

E. L. Reed, of the Halcomb Steel Company, has opened an office in room 702 Connecticut Building, 36 Pearl street, Hartford, Conn.

V V

Richard P. Tell, president of the Milwaukee Metal Trades & Founders' Association and the National Brake & Electric Co., has been appointed chairman of Wisconsin division, region 17, of the War Industries Board, to fill the vacancy caused by the resignation of August H. Vogel, of Milwaukee.

V V

James Taylor has resigned his position with the Latshaw Steel & Metal Products Corporation and the Pennsylvania Safety Company, to become treasurer of the Steel Industries Corporation, 261 Broadway, New York.

V V

R. Hueber has been appointed secretary of the Steel Industries Corporation, having recently resigned his position with the Latshaw Steel & Metal Products Corporation as export manager.

V V

P. P. Crampton has resigned his position with the Hull Iron & Steel Foundries, Rigaud, Quebec, to become a partner in the firm of Burnett & Crampton, engineers and iron founders. Mr. Burnett was formerly the electrical engineer of the Canada Cement Company, Montreal.

V V

Leonard W. Egan, special engineer for the Wellman-Seaver-Morgan Company, Cleveland, O., has resigned his position to accept a similar position with the Electric Furnace Company at Alliance, O. Mr. Egan was for five years electrical engineer for the Pittsburgh Crucible Steel Company, Midland, Pa.

V V

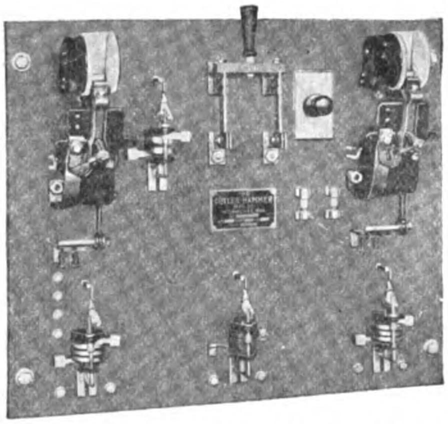
F. J. O'Brien, formerly sales manager and mill manager for the Globe Seamless Tube Co., has been made general manager, with offices in Milwaukee.

WITH THE EQUIPMENT MANUFACTURERS

SAFETY FIRST FOR CRANE AND OPERATOR.

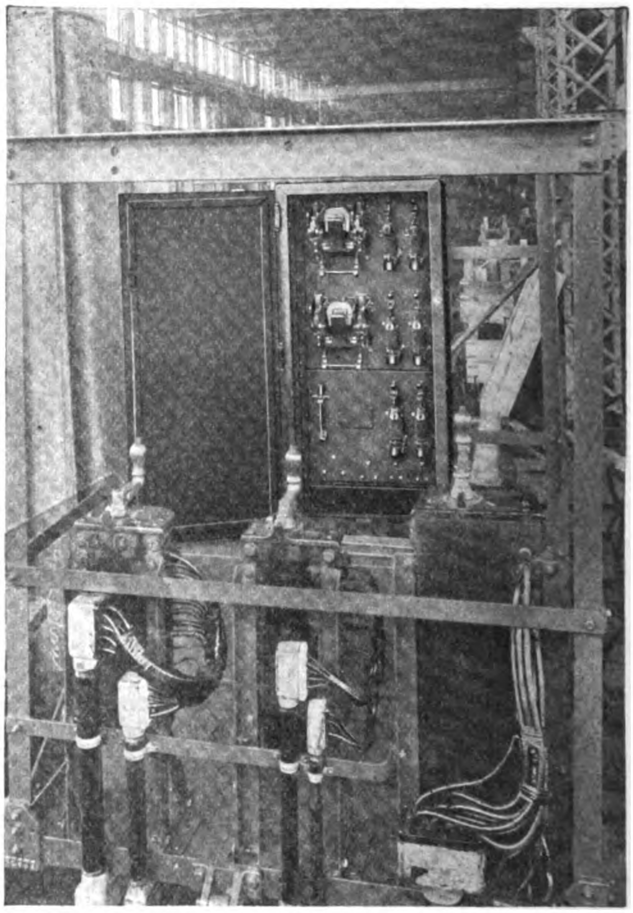
The average crane cab built a few years ago before the advent of safety first ideas, and even some cabs now manufactured give practically no protection to the motors and actually present hazards to the operator. Picture a cab of angle iron and sheet metal construction with not a great deal of head room; a limited floor space with at least three controllers, the operator and his stool; then add to this a switch-board mounted in the cab, with four or more exposed knife switches and fuses, and you have conditions which make an accident to the crane, or operator, or both, very liable. There is no end of things that might happen and probably have happened to cranes and operators, due to this lack of electrical protective devices. By simply removing the dangerous open switch board and installing in its place a crane protective panel (shown in the accompanying illustrations) mounted in a steel cabinet all the danger of the electrical shock will be removed and assured protection given to the motors and operator.

These panels take the place of the various circuit breakers, knife switches, fuses, etc., previously mounted in the crane cab, giving a complete switchboard on which are arranged all the necessary protective devices and safety features. No-voltage and overload protection is provided for each motor supplied through the panel, a thing hardly possible with the usual equipment. The control of the panel is obtained through a push button station. The control circuit is so arranged that one clapper switch is closed when the "start" button is depressed and the other when the "start" button is released. In case an overload or ground condition remains the first switch closed would be opened when the second switch is closed, thus obtaining the "non-closing" or "overload" feature.


Standard direct current crane protective panel for use with manually controlled cranes.

To start the crane the operator merely depresses the "start" button for an instant before manipulating the motor controllers, this requiring far less time than closing numerous circuit breakers and fuses. To shut off the power from all circuits, he touches the "stop" button. If he wishes to inspect any motor, or leave the crane temporarily in an inoperative condition, he can withdraw the safety plug and take it with him. As a further preventative against starting the crane when it is stopped for any repairs, both the electrician and the crane operator can be provided with separate locks, which when inserted in hinged clips of the main line knife switch, prevent it from being closed.

The direct current crane panel shown in the smaller cut has all of the following apparatus: One double pole single throw knife switch, with means for locking the switch open by inserting one of two padlocks (one for the operator and one for the electrician); one main circuit, automatic reset overload relay on one side of the line; one automatic reset overload relay for each crane motor and connected on the opposite side of the line to the main circuit relay; two magnetically operated main line clapper switches, one for each side of the line; one operator's safety plug which will open the control circuit when removed from the panel; and two enclosed fuses in the control circuit and terminal lugs for external connections to mains, motorheads, and control push-button stations.


Special crane protective panel for cranes having three Polyphase motors. Panel provides two inverse time-element overload relays for each motor.

The installation view shows a special alternating current protective panel for three polyphase motors. Each motor has two, hand-reset, time limit overload relays, one in each of two phases, to protect the motors against overload. The two double pole magnetic main line switches open all three phases; the connections being so arranged to give double

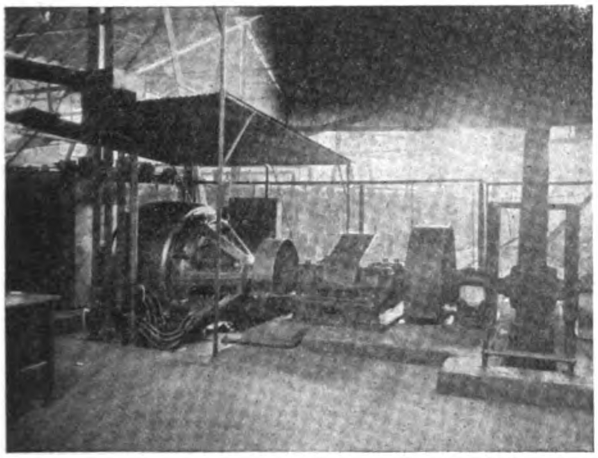
WITH THE EQUIPMENT MANUFACTURERS

safety for should one switch become inoperative the other would open two phases and stop the motor. These two switches are controlled from a push button station placed near the operator. The single pole knife switch shown in the lower left hand corner of the panel is also connected in the control circuit, and may be locked open with an ordinary padlock to prevent accidental and unauthorized operation of the crane.

These protecting panels are made by the Cutler-Hammer Manufacturing Company of Milwaukee for cranes having either alternating or direct current motors aggregating 50 to 400 horsepower.

MOTOR SUCCESSFULLY REPLACES STEAM ENGINE.

The installing of electric motors to take the place of steam engines in the plant of the Cleveland Hardware Company, Cleveland, O., has proven a success. The company, which manufactures drop forgings for automobile and similar class of work, had, prior to the installation of the motors, been operating for 35 years a nine-inch merchant rolling mill belted to a steam engine, which at the time of the recent change had outlived its usefulness. Frequent breakdowns compelled the company to consider a new driving unit. After careful consideration and investigation of the matter, the electric motor was the logical solution to the problem. The worth of the judgment displayed is determined by the entire absence of any trouble since the installation and an economy of operation better than was anticipated.



Wound rotor motor driving rolling mill at plant of Cleveland Hardware Company—Nuttall flexible coupling.

One of the interesting features connected with this installation is the fact that the electric power for the operation of the mill is purchased from the local lighting plant, the Cleveland Illuminating Company, at a price which is much more reasonable than could be obtained by means of a privately owned plant.

A noticeable increase in the mill's production has been evident since the installation. This is due to the constant even speed obtained by the motor.

The simplicity of the equipment is perhaps the most striking feature of it. The motor of Westinghouse type was placed close to and connected by gears to the rolls, and this with the transformers and control constitutes all the necessary apparatus.

Power is obtained from the illuminating company at 11,000 volts, 60 cycles, three phases and stepped down by means of a three-phase oil insulated self cooled Westinghouse transformer to motor voltage; namely 3,200 volts. The motor is of the Westinghouse wound-rotor type with a rating of 450 horsepower at 900 r.p.m. and 360 horsepower at 720 r.p.m. These synchronous speeds are obtained through a double winding designed to give the motor either eight or ten poles, according to the speed desired.

The synchronous speeds of the motor are reduced tc speeds of the mill shaft of 240 and 192 revolutions per minute respectively by means of a herringbone type gear which operates in oil in a completely enclosed case.

By means of a Nuttall spring coupling which is of the flexible coupling type, especially designed for steel mill service, the motor shaft is connected to the pinion. A similar coupling connects the gear to a 10-ton, open-hearth steel flywheel 12 feet in diameter, which is mounted on two extra heavy pillow blocks, the other end being connected to the rolling mill. The wheel is made in one piece with rectangular arms.

The control of the equipment is handled by a two-panel Westinghouse switchboard mounted on angle iron frame work. The switches for changing the windings on the motor from eight to ten poles are oil immersed, one in the primary and one in the secondary circuit. Proper markings are placed thereon so the mill operator can easily manipulate them. The primary breakers, though mechanically interlocked, can be closed one at a time.

In emergency cases, when it is necessary to stop the mill quickly, the running breaker is tripped, which causes all the secondary breakers to open. The operation then closes the reverse breaker, which quickly brings the motors to rest.

The operation has been a success from the beginning and in the opinion of the officials of the company, electric drive is the most desirable form of motor power to be considered for rolling mills. An idea of the work being done by the mill may be gained from the following figures.

In an average three-hour shift, the average tonnage of ⅝ inch rounds from 4 by 4 inch billets, 90 pounds to 100 pounds weight, 25 per cent carbon, is 35 tons; ⅞ inch splares, 45 tons; 1¾ inch by 1¼ inch flats, 40 tons, 100 to 135, 4 by 5-16 inch flats, 35 tons; and 2 by 3, 40 pound, 15 per cent carbon, ¾ by 3-16 inch flat, 20 tons; 40 pound, ⅜ inch round, 20 tons; 55 pound, ½ by 5-16 inch oval, 30 tons.

The entire electrical equipment was furnished and installed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

ELECTRIC SOLDERING IRONS.

C-H electric soldering irons and hand tools is the title of a new eight-page envelope folder just issued by the Cutler-Hammer Manufacturing Company of Milwaukee and New York. The folder shows two views of the soldering iron which has a threaded heating core over which the tip is screwed. A new automatic rack, which has recently been

Trade Notes

A. J. Barnes has been appointed export manager of the Shepard Electric Crane & Hoist Co., with headquarters at Montour Falls, N. Y. Mr. Barnes will also continue to be publicity director.

The Booth Hall Company, Chicago, electric furnace builders and metallurgists, have moved their sales and administrative offices from 565 West Washington boulevard to 2309 Archer avenue, where only the engineering and construction departments have heretofore been located. By this change all departments of the business are combined and the furnaces in course of construction are at all times under the inspection of the officials of the company.

The American Metallurgical Corporation, Franklin Trust Building, Philadelphia, has just been awarded a contract by the aircraft division for the installation of special heat treatment equipment at the plant of the Ohio Seamless Tube Company, Shelby, O. The installation is in connection with the heat treatment of airplane tubes and it is hoped that the efficiency of the tubes will be increased to such an extent that a large amount of weight will be saved in the planes, allowing for the general increase of efficiency throughout. The heating units to be installed are to be supplied by the General Electric Company under the supervision of Mr. Collins, chief of the industrial heating division.

The American Iron & Steel Institute has published a new edition of its booklet on maximum prices on iron and steel products as agreed upon by government officials and committees of the institute, together with prices, extras and differentials recommended by its committee on steel and steel products. This booklet comprises 180 pages. It is bound in paper cover, like that of last January, and sells at the same price, namely, 50 cents a copy, $5 a dozen and $35 a hundred, transportation prepaid.

The Quigley Furnace Specialties Company, New York, has secured contract for a powdered coal plant from the Whitaker Glessner Company, Beech Bottom Works, W. Va., to furnish four tons of powdered coal fuel per hour to supply 20 furnaces for heating 6-inch shell forgings. This equipment is arranged for large extensions for future applications in other departments in the mills including boilers.

The United States Civil Service Commission is greatly in need of stenographers and typists, and is conducting a campaign to secure this necessary help. In the matter of housing in Washington, it may be said that the room registration office of the District Council of Defense, at 1321 New York avenue, has on its lists more than 4,000 rooms which have been carefully inspected and are available for new appointees. The usual charge for rooming accommodations with board, that is, the two principal meals of the day, is $40 a month, but in order to obtain this rate two persons must ordinarily occupy one room. In addition, the government will soon erect residence halls, including cafeterias, for the accommodation of government employes in Washington.

Obituary

Samuel A. Newman, aged 41 years, died in a hospital at Chicago recently. He was president of the Ohio Iron & Steel Co., and a director of the Chicago Association of Jewish Charities.

Thomas Edwards died August 27 at Sheffield, Ala., after a brief illness. He was for years manager of the furnace plant for the Tennessee Coal, Iron & Railroad Co. at Ensley, Ala., and for eight years manager of the furnace for the Central Coal & Iron Co. at Holt, Ala.

Nicholas Kelly, aged 74 years, died at his home in Pittsburgh on Wednesday, September 11, after an illness of three months. He was president of N. Kelly & Sons Foundry Co. and had been engaged in the foundry business about 60 years.

Persifor F. Smith died at his home in East End, Pittsburgh, September 15. He was for some years president of the Wellsville Plate & Sheet Iron Co., taken over by the American Sheet & Tin Plate Co., and from 1900 to 1906 manager of the Wood works of that company at McKeesport, Pa.

Louis A. Hutchinson died recently at Bemus Point, N. Y., where he had gone on a vacation. He was for a number of years cashier at the Lucy furnaces of the Carnegie Steel Company.

Frank Toepfer died suddenly of heart failure at his home in Milwaukee August 28, aged 68 years. Mr. Toepfer was formerly president of Wenzel Toepfer & Sons, but ill health had compelled him to retire from active business several years ago.

Trade Publications

Sand Blasting—The Pangborn Corporation, Hagerstown, Md., has issued a booklet which sets forth in a concise form some practicable data on the subject of sand blasting. The booklet, which is entitled "Principles and Data of Sand Blasting," should be of value either in the selection of new equipment or the efficient operation of installations already in operation.

"Magnet-Operated Brakes for Direct Current Service" is the title of a new page standard descriptive booklet, known as Booklet "G," just published by the Cutler-Hammer Manufacturing Company of Milwaukee. The front cover illustration shows a typical application of this brake installed on a V-grove traction type passenger elevator. The booklet makes mention of the many desirable operating features that have been secured by recent improvements in design, and points out that by lowering the position of the magnet and making the magnet armature an integral part of one of the arms carrying the brake shoes, the construction has been simplified, fewer parts are required, compactness is secured, and the parts made extremely strong and rugged without adding excessive weight. The new design makes these brakes especially applicable for use on a crane, hoist or bridge. Ratings, dimensions, engineering data and the formula for determining the retarding torque required for any brake installation are given. The booklet lists the standard sizes, which vary from 8 to 30 inches in diameter and from 15 to 300 horsepower capacity.

Drag Scraper—The R. H. Beaumont Company, Philadelphia, Pa., has recently issued catalogue 38, describing and illustrating the Beaumont drag scraper system for the ground storage of coal.

Scales—The Standard Scale & Supply Co., 1631 Liberty avenue, Pittsburgh, Pa., has recently published a very complete and well illustrated catalogue describing their products.

Vulcan-Orsat—The "Vulcan Forge," which is the house organ of the Vulcan Fuel Company, 230 South La Salle street, Chicago, publishes in a recent issue an interesting description of the Vulcan-Orsat apparatus. After 15 years of experience with various types of flue gas analysis instruments, the experts of the Vulcan Fuel Economy Company have evolved the Vulcan-Orsat, an instrument which they introduce to the public interested in fuel conservation and boiler room economy as a decided departure from instruments now on the market, and especially strong in the four prime requisites of precision, ease of control, durability and quick interchangeability of parts.

Society Meetings

American Electrochemical Society, Princeton, N. J., September 30-October 2.

Institute of Metals Division, A. I. M. E., Milwaukee, Wis., October 8-11.

Iron and Steel Members, A. I. M. E., Milwaukee, Wis., October 8-10.

American Foundrymen's Association, Milwaukee, Wis., October 7-12.

The next regular meeting of the Engineers' Society of Western Pennsylvania will be held October 15 at Pittsburgh. The structural section will meet October 8.

Business show, New York, N. Y., October 21-16.

Western Pennsylvania Division of National Safety Council meeting to be held in Pitsburgh October 30.

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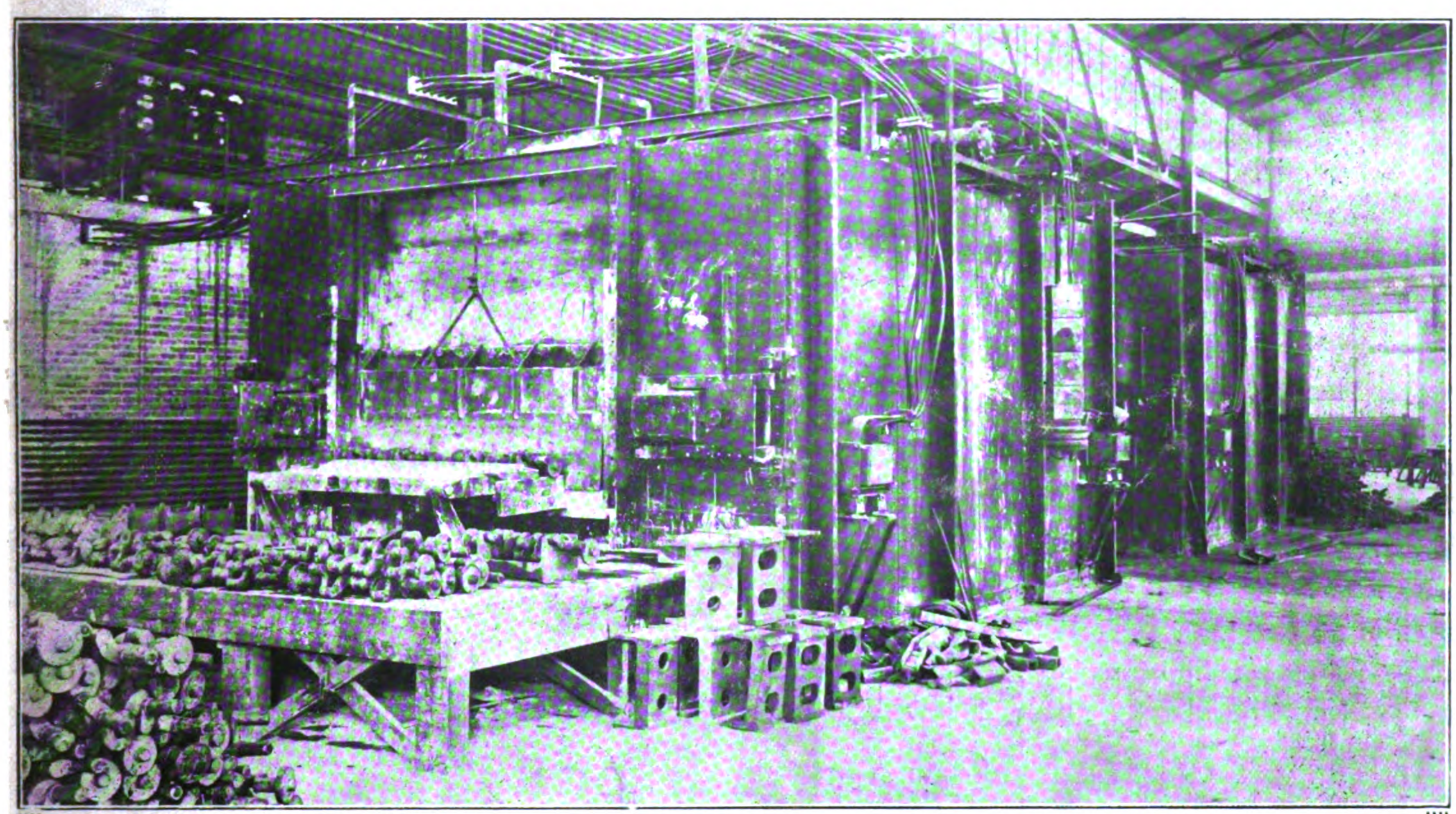
The Blast Furnace and Steel Plant

Pittsburgh, October, 1918



BAILY ELECTRIC FURNACES

¶ The question of transportation of fuel for heating, annealing or heat treating is best solved by the Baily Electric Furnace. Your plant is run by electric motors. Your heating operations should be conducted by electric furnaces. The analogy is clear, excepting that electric furnaces are a greater step in advance over oil or gas fired furnaces than motor drive was over old line shaft steam engine power.

By their use you obtain a precision that can not be equalled by any fuel fired furnace, at a cost, all things considered, often lower than by oil or gas.

Adapted for heating, annealing, heat treating, and for the melting of non-ferrous metals and alloys.

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